CHAPTER 4

Project and Research Recommendations Specific to Subareas

Chapter 4. Project and Research Recommendations Specific to Subareas

Background and Context of Chapter

This chapter provides an initial list of recommendations for habitat protection, restoration, and enhancement projects and research that address identified factors of decline for salmon habitat. These project recommendations are for the core production subareas, migratory and rearing corridors, and satellite production subareas for chinook salmon in the Lake Washington/Cedar/ Sammamish Watershed. (Map 3 provides a comprehensive look at the WRIA 8 subareas.) As described in the near-term strategy in Chapter 2, the core production subareas are those river and creek systems that are the primary spawning grounds for core populations of chinook salmon; the migratory and rearing corridors are the water bodies through which most chinook salmon must travel during the course of their life cycle; and the satellite creeks are those that support the core production subareas.

The core production subareas, migratory and rearing corridors, and satellite production subareas in the Lake Washington/Cedar/Sammamish Watershed are:

1. Nearshore/Estuary (migratory and rearing corridor)
2. Hiram M. Chittenden Locks (partial migratory barrier)
3. Ship Canal/Lake Union (migratory and possible rearing corridor)
4. Lake Washington (migratory and rearing corridor)
5. Lake Sammamish (migratory and possible rearing corridor)
6. Sammamish River (migratory and possible rearing corridor)
7. Cedar River and chinook-bearing tributaries: Rock Creek, Walsh Lake Diversion, Peterson Creek, and Taylor Creek (core production subarea)
8. Bear Creek and chinook-bearing tributaries: Cottage Lake Creek, Cold Creek, and Evans Creek (core production subarea)
9. Issaquah Creek and chinook-bearing tributaries: North Fork Issaquah Creek, East Fork Issaquah Creek, Fifteenmile Creek, Carey Creek, and Holder Creek (core production subarea)
10. Little Bear Creek (satellite production subarea)
11. North Creek (satellite production subarea)

12. Swamp Creek (satellite production subarea)

13. Kelsey Creek (satellite production subarea).

The recommendations in this chapter were developed by the WRIA 8 Technical Committee (see Chapter 9, Acknowledgments, for committee roster) and are a reflection of the committee's best professional judgment on how to address the identified factors of salmon habitat decline for each of these subareas. The factors of decline are documented in the *Salmon and Steelhead Habitat Limiting Factors Report for Cedar-Sammamish Basin*, which was developed by the Washington State Conservation Commission and the WRIA 8 Technical Committee. It should be noted that the recommendations were developed with the guiding principles laid out in the near-term strategy in mind, but have not been through a rigorous technical review. The recommendations listed are not comprehensive nor are they prioritized. However, the criteria for choosing early actions discussed at the end of Chapter 3, General Action Guidance, can help set priorities for near-term actions. Most of the listed actions still need feasibility, cost-effectiveness, and risk analyses, as well as design work before implementation can begin.

Recommendation for Subarea Stewards

To help implement actions that will build toward salmon habitat conservation, jurisdictions should consider hiring or sharing subarea stewards. The key is to have a point person who is familiar with both the specific drainage basin conditions and the local community and who can work with jurisdictions, landowners, businesses, and organizations to get projects implemented on the ground. Model programs for this include the King County Basin Stewards, the City of Seattle Urban Creeks Biologists, the Bellevue Stream Team, and others.

How to Use the Project Recommendations

Jurisdictions and interested parties in WRIA 8 should use the goals and objectives for each subarea to help understand the overall vision for each subarea. Recommendations in this section are organized by action alternatives, potential projects, and research. Action alternatives are general recommendations for the type of actions that should be taken to address an identified factor of decline. For example, to address degraded riparian conditions one could look for opportunities to replant riparian areas with native vegetation. Action alternatives are intended to help generate additional projects, recognizing that not all the potential technically sound projects are identified in the Action Agenda. Potential projects are more specific on-the-ground opportunities that have been identified for applying an action alternative, such as replanting riparian vegetation at a specific location in a subarea. If appropriate, implementers can pursue an identified potential project or use the action alternatives to help generate additional projects in the future, using the near-term strategy (see Chapter 2) and the criteria for choosing early actions (see the last section of Chapter 3, General Action Guidance).

Map 3. WRIA 8 Subareas and Urban Growth Area

8.5 x 11***, color*** (must fall on odd-numbered page)

2nd page for Map 3

Role of Research in the Action Agenda

For some factors of decline, action alternatives have been listed, but no specific projects could be identified at this time. Although the factors of decline have been documented, their role in each subarea and how to address them may not be completely understood yet by scientists. Research is required, particularly for the factors of decline with low certainty. Part of the strategy of the Action Agenda is to conduct research that will lead to additional science-based projects and a better understanding of the Lake Washington/Cedar/Sammamish Watershed. Like the habitat recommendations, the research recommendations included here are not comprehensive nor are they prioritized. A more comprehensive research agenda for WRIA 8 will be developed as part of the strategic assessment that will provide the scientific foundation for the long-term salmon conservation plan.

This chapter addresses only potential projects (that is, habitat acquisition, restoration, and enhancement projects) and research. The identified factors of decline also need to be addressed through regulatory and policy measures and public outreach programs. See chapters 5 and 6 for regulatory recommendations and public outreach recommendations.

Nearshore/Estuary

The Nearshore/Estuary subarea encompasses approximately 24 miles of shoreline. (See Map 4, Nearshore/Locks Subareas.) The northern boundary of the subarea is Elliot Point and the southern boundary is West Point. (The West Point boundary represents the planning boundary for WRIA 8 salmon conservation efforts and is not the true boundary as delineated by the State of Washington.) This subarea has been highly altered through human activities such as shoreline development, dredging, and shoreline hardening. One of the most imposing obstacles to restoring natural processes along the nearshore is the railroad grade that runs for most of its length. The estuary is artificial and limited to the Salmon Bay area immediately downstream of the Hiram M. Chittenden Locks. While the changes that have occurred in the Nearshore/Estuary are well documented, the effects of those changes on salmon growth and survival are not well known. The Nearshore/Estuary environment is used by both adult and juvenile salmon of all species, but particularly by chinook and chum.

The following factors of decline were identified by the WRIA 8 Technical Committee for the Nearshore/Estuary: loss of habitat in the migratory and rearing corridor; loss of riparian functions; alteration of habitat-forming processes; poor water quality and sediment degradation; and introduction of non-native species.

The primary goal for the Nearshore/Estuary subarea is to protect and restore habitat-forming processes and habitat conditions that contribute to ecological requirements of adults and juvenile salmon, notably feeding, migration, physiological transitions, and refuge areas.

The following objectives will help achieve this goal:

- Protect existing undeveloped shoreline areas and maintain or restore ecosystem processes and functions that create habitat.
- Protect and enhance marine riparian vegetation.
- Restore shoreline and nearshore habitat complexity and provide access to historically accessible habitats.
- Investigate the possible impacts of water and sediment quality degradation on juvenile salmon, forage fish production, and predator/prey dynamics.
- Investigate the possible impacts of non-native plants and animals on the survival of salmon that utilize the Nearshore subarea.

Tables 4-1 through 4-3 present near-term recommendations for the Nearshore/Estuary subarea. The tables are organized by action alternatives, potential projects, and research. Action alternatives are general recommendations for actions that should be taken to address an identified factor of decline. Potential projects are more specific on-the-ground opportunities that have been identified for applying an action alternative, such as replanting riparian vegetation at a specific

location in a subarea. Research activities are designed to help scientists gain a better understanding of a subarea's factors of decline and to learn what roles the factors play and how to address them.

Table 4-1. Nearshore/Estuary Action Alternatives

Action Alternative No./Action Alternative	Factors of Decline Addressed	Projects Identified
Nearshore AA 1		
Identify critical areas of Nearshore/Estuary subarea for protection, restoration, and enhancement.	Loss of habitat in the migratory and rearing corridor Loss of riparian functions Alteration of habitat-forming processes	Nearshore P 1, 2, 3, 4
Nearshore AA 2		
Evaluate existing riparian conditions throughout Nearshore/Estuary subarea in order to identify opportunities to protect and enhance riparian vegetation.	Loss of habitat in the migratory and rearing corridor Loss of riparian functions Alteration of habitat-forming processes	Nearshore P 5
Nearshore AA 3		
Identify, protect, and reconnect existing refuge areas and create potential refuge areas. Projects should be carefully monitored for effectiveness and to ensure that predation is not increased by providing refuge areas.	Loss of habitat in the migratory and rearing corridor Loss of riparian functions Alteration of habitat-forming processes	Nearshore P 1, 2, 3, 4
Nearshore AA 4		
Identify areas where it is feasible to remove nearshore bank armoring as a means of restoring shoreline processes and functions, such as sediment input and transport, and consequently rearing habitat quality and quantity.	Loss of habitat in the migratory and rearing corridor Loss of riparian functions Alteration of habitat-forming processes	No projects identified at this time
Nearshore AA 5		
Enhance the mouths of small stream tributaries entering Puget Sound in order to restore large woody debris recruitment, sediment transport, and freshwater/saltwater interface (for example, railroad bridge crossings at numerous Puget Sound stream mouths).	Loss of habitat in the migratory and rearing corridor Loss of riparian functions Alteration of habitat-forming processes	No projects identified at this time
Nearshore AA 6		
Restore estuarine functions where possible.	Loss of habitat in the migratory and rearing corridor Loss of riparian functions Alteration of habitat-forming processes	No projects identified at this time

Action Alternative No./Action Alternative	Factors of Decline Addressed	Projects Identified
Nearshore AA 7		
Minimize or eliminate overwater structures.	Loss of habitat in the migratory and rearing corridor Loss of riparian functions Alteration of habitat-forming processes	No projects identified at this time
Nearshore AA 8		
Identify areas along the shoreline under public ownership or willing private ownership where shoreline could be modified to a more natural condition. Consider a demonstration project with soft erosion control.	Loss of habitat in the migratory and rearing corridor Loss of riparian functions Alteration of habitat-forming processes	No projects identified at this time
Nearshore AA 9		
Identify properties for potential acquisition as a means of restoring dynamic sedimentation processes.	Loss of habitat in the migratory and rearing corridor Loss of riparian functions Alteration of habitat-forming processes	No projects identified at this time

Potential projects for the Nearshore/Estuary subarea are listed in the following table and can be located on Map 4. Each project has been assigned a number (P 1, P 2, etc.). On the map, corresponding numbers indicate the location of the projects. For example, a map point marked 2 refers to project 2. Not all projects are mapped, because some are not being conducted in a specific location. Projects that are not mapped are noted in the table.

Table 4-2. Nearshore/Estuary Potential Projects

Project Name	Type of Project
Nearshore P 1 Salmon Bay Natural Area	**Protection/Restoration**
Increase rearing/refuge area for millions of salmon smolts that migrate through and use this transition area between freshwater and saltwater. As proposed, project goals would be to acquire the property, plant native shoreline vegetation, remove riprap, re-slope shoreline, and add gravel/sands where appropriate. The Salmon Bay Natural Area is downstream of the Hiram M. Chittenden Locks on the north bank between Hiram's restaurant and the railroad bridge, and behind the U.S. Army Corps of Engineers' finger pier. Project partners include Groundswell Northwest, City of Seattle, and U.S. Army Corps of Engineers.	
Nearshore P 2 Seattle Street End Near Salmon Bay	**Restoration**
Increase rearing/refuge habitat for juvenile salmon by restoring the conditions at this site, which is located downstream of the Salmon Bay Natural Area. Alternative bank protection measures would be used to create a more gradual slope. In addition, riparian and emergent vegetation could be planted, and the substrate could be amended to restore nearshore habitat. Currently there is a failed bulkhead at this site. The adjacent property owner has applied for permits to rebuild the bulkhead. The property is publicly owned; therefore, funds would be needed for restoration, but not acquisition. Potential project partners include City of Seattle and U.S. Army Corps of Engineers.	

Project Name	Type of Project
Nearshore P 3 Commodore Park Restoration	**Restoration**
Explore feasibility of habitat restoration at Commodore Park, located immediately downstream of the Hiram M. Chittenden Locks on the south bank. Purpose of the project would be to increase the limited high-quality rearing/refuge habitat for millions of salmon smolts that migrate through and use this area as a critical transition between freshwater and saltwater. Potential project partners include City of Seattle and U.S. Army Corps of Engineers.	
Nearshore P 4 City of Mukilteo Tideland and Shoreline Acquisitions (not mapped)	**Protection**
The City of Mukilteo is evaluating the nearshore within its jurisdiction for additional potential tideland and shoreline habitat protection projects.	
Nearshore P 5 City of Mukilteo's Riparian Vegetation Enhancement (not mapped)	**Enhancement**
In its 2002 Draft Shoreline Plan, the City of Mukilteo will be identifying priority properties for a nearshore riparian revegetation enhancement program. Using volunteer labor, the City will be evaluating locations for riparian revegetation projects.	

Table 4-3. Nearshore/Estuary Research

Research No.	Research Description	Factors of Decline Addressed
Nearshore R 1	Investigate and understand the potential impacts of degradation of water and sediment quality on juvenile salmon, production of forage fish, and predator/prey dynamics. ▪ Evaluate exposure to endocrine-disrupting chemicals. ▪ Evaluate extent and impacts of pesticides (for example, Diazinon). ▪ Expand evaluation of benthic community structure in watershed to more fully understand salmon prey base. ▪ Evaluate Washington Department of Ecology's study of sediment quality in Salmon Bay.	Water quality and sediment degradation
Nearshore R 2	Determine the abundance of non-native plants and animals present in the nearshore environs and investigate the dynamics and interactions between non-native species and salmon in the nearshore environment. ▪ Survey existing non-native species and their abundance. ▪ Investigate the dynamics and interactions between non-native fish species and salmon in the nearshore environment. ▪ Investigate the relationship between invasive plants and animals and the abundance of predators.	Introduction of non-native species
Nearshore R 3	Evaluate impact of marine riparian vegetation loss on marine ecosystem functions such as salmon prey production, organic input, shade, and water quality, and how this loss of marine ecosystem affects salmon.	Loss of habitat in the migratory and rearing corridor Loss of riparian functions Alteration of habitat-forming processes
Nearshore R 4	Investigate life history and behavioral ecology of chinook salmon (including timing, distribution, growth, movement and migration patterns, prey distribution and selectivity, habitat characteristics and selectivity, interspecific interactions, food web linkages, and impact of forage fish) in Nearshore subarea of WRIA 8.	Loss of habitat in migratory and rearing corridor Loss of riparian functions; Alteration of habitat-forming processes

Map 4. Nearshore and Locks Subareas

Hiram M. Chittenden Locks

The Hiram M. Chittenden Locks (more commonly known as the Ballard Locks) are the outlet of the Lake Washington/Cedar/Sammamish Watershed. (See Map 4, Nearshore and Locks Subareas.) The Locks are located on the Ship Canal at the entrance to Salmon Bay, which is 1.2 miles from Puget Sound. The U.S. Army Corps of Engineers constructed the Locks in 1916 in order to maintain Lake Washington lake levels and to allow for navigation between Puget Sound and Lake Washington. The Hiram M. Chittenden Locks are a partial migratory barrier for salmon in WRIA 8, particularly for juvenile salmon migrating to saltwater and for adult salmon in low-flow, high-temperature conditions.

The following factors of decline were identified by the WRIA 8 Technical Committee for the Hiram M. Chittenden Locks: fish access and passage barriers, poor water quality (increased temperatures), freshwater/saltwater exchange (all these factors are also part of the fish passage problem), and predation.

The primary goal for the Locks is to allow safe, unimpeded fish passage.

The following objectives will help achieve this goal:

- Continue to identify and implement measures to allow safe, unimpeded fish passage at the Locks.
- Investigate and understand the predator/prey dynamics as affected by operation of the Locks facilities.

Tables 4-4 through 4-6 present near-term recommendations for the Hiram M. Chittenden Locks subarea. The tables are organized by action alternatives, potential projects, and research. Action alternatives are general recommendations for actions that should be taken to address an identified factor of decline. Potential projects are more specific on-the-ground opportunities that have been identified for applying an action alternative, such as replanting riparian vegetation at a specific location in a subarea. Research activities are designed to help scientists gain a better understanding of a subarea's factors of decline and to learn what roles the factors play and how to address them.

Table 4-4. Hiram M. Chittenden Locks Action Alternatives

Action Alternative No./Action Alternative	Factors of Decline Addressed	Projects Identified
Locks AA 1		
Modify and manipulate Locks facilities and operations to increase safe passage of adult and juvenile salmon.	Fish access and passage barriers Poor water quality (increased temperatures, freshwater/saltwater exchange)	Locks P 1

Potential projects for the Hiram M. Chittenden Locks subarea are listed in the following table and can be located on Map 4. Each project has been assigned a number (P 1, P 2, etc.), and for projects that include more than one task, a letter has been assigned to each task (a, b, c, etc.). On the map, corresponding numbers and letters indicate the location of the projects and tasks. For example, a map point marked 2a refers to project 2, task a.

Table 4-5. Hiram M. Chittenden Locks Potential Projects

	Project Name	Type of Project
Locks P 1	**Modification of Locks to Increase Safe Passage of Salmon**	**Fish Passage Improvements**
1a	Further reduce lockage speed for large locks to reduce smolt entrainment in filling culverts.	
1b	Improve downstream entrance to the fish ladder with a telescoping weir and a horizontal gate. Close the slot on the downstream end of the ladder to concentrate flow.	
1c	Add fishway entrance lighting for the ladder.	

Table 4-6. Hiram M. Chittenden Locks Research

Research No.	Research Description	Factors of Decline Addressed
Locks R 1	Investigate further modification of Locks facilities for improved fish passage. ▪ Evaluate means to increase the water available for fish passage, including reducing leaks at the locks, reducing the frequency of lockages, modifying or moving the entrance of the saltwater drain, recycling of reclaimed wastewater, changing salinity management, and modifying lake elevation management. ▪ Evaluate whether dissolved oxygen, salinity, and temperature are major fish barriers for migrating adults and juveniles, and establish ways to minimize. Evaluate optimal waterflow to the fish ladder, temperature, and the mixture of saltwater to freshwater. ▪ Evaluate installation of a controllable gate at the north end of the fish ladder.	Fish access and passage barriers Poor water quality (increased temperatures, freshwater/saltwater exchange)
Locks R 2	Investigate ways to reduce water temperatures and the abrupt freshwater/saltwater transition at the Locks. ▪ Evaluate the feasibility of a multi-level intake for the fish ladder to provide cooler water for the fish ladder and reduce the abrupt freshwater/saltwater transition (depends on water temperature stratification); determine whether the cooler water attraction flow would significantly improve fish passage/survival. ▪ Experiment with cooling water temperatures upstream of the large locks by generating an upstream lockage every 4 hours, provided a normal lockage does not occur in that time and there is adequate water. ▪ Evaluate success of smolt flume discharge to create freshwater lens downstream of the Locks that supports salmon growth and survival. ▪ Evaluate the impact of smolt flume discharges on salmon food supply downstream of the Locks. Studies indicate freshwater from the flumes contains significant amounts of daphnia, which are stunned when they enter saltwater, becoming a source of food for juvenile salmon.	Fish access and passage barriers Poor water quality (increased temperatures, freshwater/saltwater exchange)
Locks R 3	Examine predation rates and extent of predation upon juvenile salmon passing through the Locks facilities. ▪ Continue studies of upstream and downstream predator presence and dynamics.	Predation

Ship Canal/Lake Union

The Ship Canal/Lake Union subarea is defined as the area encompassing (from east to west) Montlake Cut, Portage Bay, Lake Union, Fremont Cut, and the Ship Canal up to the Hiram M. Chittenden Locks. (See Map 5, Ship Canal/Lake Union Subarea.) The construction of the Lake Washington Ship Canal created a series of navigational channels connecting Lake Washington, Lake Union, and Puget Sound. In 1916, the Hiram M. Chittenden Locks were constructed at the mouth of the Salmon Bay waterway. Land use in the area is primarily composed of water-dependent commercial and industrial uses, including marinas, commercial shipyards, and dry-docks, with commercial and residential development bordering the shoreline of Lake Union. Relatively little is known about the natural history of salmon that utilize Lake Union for transportation and juvenile rearing. However, all the naturally produced ocean-migrating salmon that reside in the Lake Washington/Cedar/Sammamish Watershed use Lake Union as a migratory passageway to and from Puget Sound. There is thought to be little if any successful spawning in Lake Union.

The WRIA 8 Technical Committee identified the following factors of decline for the Ship Canal/Lake Union subarea: predation; degradation of riparian habitat conditions; poor water quality (increased temperatures, dissolved oxygen); and poor sediment quality.

The primary goal for the Ship Canal/Lake Union subarea is to support successful migration of adult and juvenile salmon through the Ship Canal and Lake Union.

The following objectives will help achieve this goal:

- Provide riparian function and refuge areas to ensure safe and successful migration of adult and juvenile salmon.
- Investigate opportunities to reduce unnaturally high predation that has a potential impact on the successful migration of juveniles between Lake Washington and Puget Sound.
- Understand the impact of low dissolved oxygen and increased temperatures in the Ship Canal and Lake Union on migrating adult and juvenile salmon.
- Understand the impact of degraded sediment quality in the Ship Canal and Lake Union on migrating adult and juvenile salmon.

Tables 4-7 through 4-9 present near-term recommendations for the Ship Canal/Lake Union subarea. The tables are organized by action alternatives, potential projects, and research. Action alternatives are general recommendations for actions that should be taken to address an identified factor of decline. Potential projects are more specific on-the-ground opportunities that have been identified for applying an action alternative, such as replanting riparian vegetation at a specific location in a subarea. Research activities are designed to help scientists gain a better understanding of a subarea's factors of decline and to learn what roles the factors play and how to address them.

Table 4-7. Ship Canal/Lake Union Action Alternatives

Action Alternative No./Action Alternative	Factors of Decline Addressed	Projects Identified
Ship Canal AA 1		
Identify opportunities to re-create habitat characteristics more favorable to salmon and less favorable to their non-native predators. Modify or remove docks, replace nearshore sediments, enhance riparian conditions and functions, and remove invasive aquatic macrophytes.	Predation	No projects identified at this time
Ship Canal AA 2		
Evaluate publicly owned property in Ship Canal and Lake Union (U.S. Army Corps of Engineers property, street ends, city parks, University of Washington property, etc.) for additional restoration sites. Identify opportunities to re-vegetate the Ship Canal with native vegetation. Create a functional overhanging vegetation buffer along shoreline, which will enhance habitat for juvenile salmon.	Degradation of riparian habitat condition	Ship Canal P 1

Potential projects for the Ship Canal/Lake Union subarea are listed in the following table and can be located on Map 5. Each project has been assigned a number (P 1, P 2, etc.). On the map, the corresponding number indicates the location of the project. For example, a map point marked 2 refers to project 2.

Table 4-8. Ship Canal/Lake Union Potential Projects

Project Name	Type of Project
Ship Canal P 1 Demonstration Project at Fremont Bridge	**Restoration**
Work with U.S. Army Corps of Engineers to construct a demonstration project on federal lands near the Fremont Bridge, where there is an area available for bank re-sloping, addition of native vegetation, and rock removal. Hypothetically, this would provide a refuge site for migrating juveniles. Consider impact of predators in site design.	

Table 4-9. Ship Canal/Lake Union Research

Research No.	Research Description	Factors of Decline Addressed
Ship Canal R 1	Investigate methods to reduce predation of juvenile salmon in the Ship Canal and Lake Union. ▪ Conduct controlled experiments in bass habitat minimization and reduction of bass populations in the Ship Canal and Lake Union. ▪ Investigate life history and behavioral ecology of juvenile chinook salmon in Lake Washington. ▪ Experiment with alternative dock designs (prisms, lollipop configurations, fencing off underwater portions of overwater structures to keep predators out). ▪ Investigate possibility that invasive non-native plants in Lake Union, such as Eurasian watermilfoil, increase predation of juveniles by providing refuge and ambush sites for predators.	Predation
Ship Canal R 2	Investigate ways to create refuge areas in Ship Canal and Lake Union (monitor to ensure that predation does not increase within refuge areas).	Degraded riparian habitat conditions
Ship Canal R 3	Investigate the impact of low dissolved oxygen and increased temperatures in the Ship Canal and Lake Union on migrating adult and juvenile salmon.	Poor water quality (increased temperatures, low dissolved oxygen)
Ship Canal R 4	▪ Investigate the impact of degraded sediment quality in the Ship Canal and Lake Union on migrating adult and juvenile salmon. ▪ Study bioaccumulation of metals and organic compounds in dead juvenile chinook recovered downstream of the Locks (U.S. Army Corps of Engineers). ▪ Evaluate sediment chemistry, toxicity, and benthic community structure in Lake Union (King County).	Poor sediment quality

Map 5. Ship Canal/Lake Union Subarea

Lake Washington

Covering a surface area of 22,138 acres, Lake Washington is the second-largest natural lake in Washington state. (See Map 6, Lake Washington Subarea.) It is approximately 20 miles long and has more than 50 miles of shoreline. The main inflow to the lake is the Cedar River, from the south. The Sammamish River also contributes to its surface flow, entering Lake Washington from the north. The lake drains to Puget Sound via the Lake Washington Ship Canal. Small streams that also drain into Lake Washington include Thornton Creek, Juanita Creek, Kelsey Creek, Lyon Creek, and May Creek. Lake Washington has experienced many physical changes over time. In 1916, the Black River, which was the lake's natural outlet, was blocked, and the outlet was changed to the Hiram M. Chittenden Locks. A few years earlier, the Cedar River was redirected into Lake Washington to reduce flooding in the City of Renton. These actions lowered and permanently regulated the lake's level and resulted in other changes to shorelines and wetlands. The majority of the shoreline is now in urban residential land use, except for a few commercial and industrial developments. All species of salmon in the Lake Washington/Cedar/Sammamish Watershed migrate through, and rear in, Lake Washington. Research is being done to better understand how salmon use Lake Washington.

The WRIA 8 Technical Committee identified the following factors of decline for the Lake Washington subarea: altered trophic interactions (predation, competition); degradation of riparian shoreline conditions; altered hydrology; invasive exotic plants; poor water quality (phosphorus, alkalinity, pH); and poor sediment quality.

The primary goals for the Lake Washington subarea are to:

- Protect and restore habitat-forming processes and habitat conditions in the Lake Washington environment that contribute to the ecological requirements of adult and juvenile salmon, such as feeding, migration, rearing, spawning, and refuge areas.
- Protect and restore biological communities favorable to salmon recovery.

The following objectives will help achieve these goals:

- Protect and restore natural lake shorelines and shallow water habitat.
- Understand invasive aquatic plant/salmon interaction and minimize negative impacts.
- Reduce water-quality impacts on salmon from stormwater entering Lake Washington and the application of aquatic plant herbicides.
- Determine how altered trophic interactions in the Lake Washington system have an impact on the survival and reproduction of salmon; identify options to alleviate the impacts.
- Understand the ecological effect of altered lake levels on salmon viability.

- Determine if increased phosphorus, alkalinity, and pH affect viability of salmon in Lake Washington.
- Determine if sediment quality is having an adverse impact on the survival and reproduction of salmon and the production of benthic food resources.

Tables 4-10 through 4-12 present near-term recommendations for the Lake Washington subarea. The tables are organized by action alternatives, potential projects, and research. Action alternatives are general recommendations for actions that should be taken to address an identified factor of decline. Potential projects are more specific on-the-ground opportunities that have been identified for applying an action alternative, such as replanting riparian vegetation at a specific location in a subarea. Research activities are designed to help scientists gain a better understanding of a subarea's factors of decline and to learn what roles the factors play and how to address them.

Table 4-10. Lake Washington Action Alternatives

Action Alternative No./Action Alternative	Factors of Decline Addressed	Projects Identified
Lake Washington AA 1		
Identify areas where it will be feasible to protect and restore natural lake shorelines and shallow water habitat and to remove bank armoring and docks. Construct demonstration projects on public lands at key locations in Lake Washington, such as Magnuson Park, Seward Park, and the mouths of the Sammamish and Cedar rivers. Between the mouth of the Cedar River and the Ship Canal, remove bulkheads, regrade shorelines, improve substrate, and plant overhanging vegetation in order to enhance rearing and refuge habitat for juvenile chinook. Monitor to determine predator use, juvenile preference for substrate size, etc. Based on results, construct additional areas.	Degradation of riparian shoreline conditions	Lake Washington P 1, 2, 3, 4, 5
Lake Washington AA 2		
Identify, protect, and restore tributary mouths entering the lake. Studies show that juvenile chinook hold and feed near the mouths of tributaries, even very small streams and drainages, during rearing and migration. Construct demonstration restoration projects of tributary mouths and evaluate stability, sedimentation rates, and juvenile/adult use and predation. It will be important to consider contaminant issues in site selections.	Degradation of riparian shoreline conditions	Lake Washington P 6
Lake Washington AA 3		
Identify opportunities to preserve, enhance, or restore lakeshore wetlands.	Degradation of riparian shoreline conditions	Lake Washington P 7, 8, 9
Lake Washington AA 4		
Identify opportunities to treat stormwater entering Lake Washington through biofiltration or other water quality techniques. Consider experimental projects.	Poor water quality (phosphorus, alkalinity, pH)	Lake Washington P 10

Potential projects for the Lake Washington subarea are listed in the following table and can be located on Map 6. Each project has been assigned a number (P 1, P 2, etc.), and for projects that include more than one task, a letter has been assigned to each task (a, b, c, etc.). On the map, corresponding numbers and letters indicate the location of the project and task. For example, a map point marked 2a refers to project 2, task a. Not all projects are mapped, because some are not being conducted in a specific location. Projects that are not mapped are noted in the table.

Table 4-11. Lake Washington Potential Projects

Project Name	Type of Project
Lake Washington P 1 Seward Park Shoreline Restoration	**Shoreline Restoration**
Restore approximately 2,000 feet of shoreline along Bailey Peninsula in Seward Bay by putting in finer substrate and overhanging vegetation (potential City of Seattle project). Demonstration project done in 2001 on east shore of Seward Park restoring 1,000 feet of shoreline.	
Lake Washington P 2 Denny Blaine Park	**Shoreline Restoration**
Implement the results of a feasibility study now under way to improve a failing seawall of concrete slabs. This would likely involve development of a new wall inland of the existing wall and a small beach cove at the north end of the shoreline (potential City of Seattle project).	
Lake Washington P 3 Lake Washington Boulevard	**Shoreline Restoration**
Remove concrete debris and blackberry bushes, regrade, and re-establish native trees and shrubs on the shoreline boulevard from East Pine Street to the Madrona Drive intersection (potential City of Seattle project).	
Lake Washington P 4 Lake Washington Boulevard South	**Shoreline Restoration**
4a Control invasive weeds at several locations and re-establish native vegetation (potential City of Seattle project).	
4b Remove debris along the water's edge in the north portion, from Mount Baker Park to Stan Sayres Park. Grade the shoreline, armor with beach gravels, and plant native riparian shrubs to return the shoreline to natural conditions (potential City of Seattle project).	
Lake Washington P 5 Magnuson Park Shoreline	**Shoreline Restoration**
Remove dumped material, concrete, and other unnecessary shoreline hardening measures, regrade, install appropriate beach gravels, and plant with native trees and shrubs in the south and north ends of the park (potential City of Seattle project).	
Lake Washington P 6 Mouth of Mapes Creek Restoration	**Restoration**
Restore mouth of Mapes Creek, which is currently in a culvert that empties into deep water in Lake Washington (potential City of Seattle project). Use as demonstration project and evaluate stability, sedimentation rates, and juvenile/adult use and predation.	
Lake Washington P 7 Be'er Sheva Park near Pritchard Island	**Restoration**
Restore wetlands at Be'er Sheva Park near Pritchard Island (potential City of Seattle project).	
Lake Washington P 8 Sammamish River Mouth	**Restoration**
Restore wetland at mouth of Sammamish River.	
Lake Washington P 9 Sand Point Wetlands	**Restoration**
Remove the old Navy commissary and surrounding buildings and pavement, regrade and plant to re-create and restore a small lake and surrounding wetland (potential City of Seattle project).	
Lake Washington P 10 Be'er Sheva Experimental Stormwater Treatment	**Stormwater Treatment**
Develop the Be'er Sheva Park experimental stormwater treatment project (potential City of Seattle project).	

Table 4-12. Lake Washington Research

Research No.	Research Description	Factors of Decline Addressed
Lake Washington R 1	Conduct a comprehensive inventory of remaining natural shoreline on Lake Washington to identify protection and potential riparian shoreline restoration projects.	Degradation of riparian shoreline conditions
Lake Washington R 2	Experiment with alternative dock design/mitigation packages that use bank softening to replace docks and bank armoring.	Degradation of riparian shoreline conditions
Lake Washington R 3	Evaluate mouths of tributaries and small drainages for adult migration access and juvenile rearing habitat. Identify potential restoration sites.	Degradation of riparian shoreline conditions
Lake Washington R 4	▪ Investigate the type of impacts altered trophic interactions in the Lake Washington system have on salmon and identify options to alleviate the impacts. ▪ Investigate life history and behavioral ecology of juvenile chinook salmon in Lake Washington. ▪ Investigate potential problem of low food availability in Lake Washington at the time juvenile fish enter the lake and how this problem can be alleviated. (Low food supply is known to be a problem for sockeye; it should be determined if it is also a problem for chinook.) ▪ Investigate life history species interactions, as well as habitat needs of juvenile salmon predators in Lake Washington, including bass, sculpin, and cutthroat trout. ▪ Investigate ways to return predator/prey relationship to a more natural balance (for example, evaluate possible experimental changes in fish management, and construct habitat alteration pilot projects). ▪ Conduct controlled experiments in bass habitat minimization and bass population reduction in Lake Washington.	Altered trophic interactions (predation, competition)
Lake Washington R 5	Investigate the ecological effect of altered lake levels on salmon. Evaluate impact on tributary mouths, wetlands, navigation, floating bridges, etc. if lake elevation changes are adopted as a means of increasing water at the Locks for improved fish passage. (Planned by U.S. Army Corps of Engineers.)	Altered hydrology
Lake Washington R 6	Investigate invasive aquatic plants/salmon interaction.	Invasive exotic plants
Lake Washington R 7	Research invasive aquatic weed management techniques to find those that are most effective and least harmful to aquatic animals.	Invasive exotic plants
Lake Washington R 8	Identify critical areas of juvenile and adult chinook migration for aquatic weeds management; control invasive aquatic weeds in those parts of the lake.	Invasive exotic plants

Research No.	Research Description	Factors of Decline Addressed
Lake Washington R 9	Investigate sources of alkalinity and pH increase and their possible effects on salmon in Lake Washington. Evaluate data to identify any possible trends in alkalinity and pH increase (for example, seasonal; if seasonal, may be related to productivity).	Poor water quality (phosphorus, alkalinity, pH)
Lake Washington R 10	Use the SR 520 floating bridge to obtain accurate data on runoff from traffic and roadways. Selected storm drains can be equipped with autosamplers to create a composite of sample storm events. Data can be used to generate estimates for the regional contribution of highway runoff pollution to individual watersheds (potential King County research project).	Poor water quality
Lake Washington R 11	Evaluate sediment quality in Lake Washington (ongoing King County work).	Poor sediment quality

Map 6. Lake Washington Subarea

Lake Sammamish

Lake Sammamish is approximately 21.7 miles long and 3.3 miles wide. (See Map 7, Lake Sammamish Subarea.) The major tributary to the lake is Issaquah Creek, which enters at the south end and contributes about 70 percent of the surface flow. Tibbets Creek to the south, and Pine Lake Creek to the east, also drain into Lake Sammamish. Discharge from Lake Sammamish is through the Sammamish River at the north end of the lake, where a flow control weir at Marymoor Park controls the discharge. Although Lake Sammamish serves as a migration route for juvenile salmon traveling to the ocean and adult salmon returning to their spawning grounds, little is known about how these fish actually use the lake. Chinook, sockeye, coho, and kokanee salmon use Lake Sammamish.

The WRIA 8 Technical Committee identified the following factors of decline for the Lake Sammamish subarea: predation; degradation of riparian shoreline conditions; poor water quality (temperature and nutrients); invasive exotic plants; degraded sediment quality; altered trophic interactions; altered macrophyte conditions; and fish access and passage barriers.

The primary goals for the Lake Sammamish subarea are to:

- Protect and restore habitat-forming processes and habitat conditions in the Lake Sammamish environment that contribute to the ecological requirements of adult and juvenile salmon, such as feeding, migration, rearing, spawning, and refuge areas.

- Protect and restore biological communities favorable to salmon recovery.

The following objectives will help achieve these goals:

- Project and restore natural lake shorelines and shallow water habitat.

- Reduce sources of phosphorus entering Lake Sammamish.

- Determine if alkalinity and pH affects viability of salmon in Lake Sammamish.

- Understand invasive aquatic plant/salmon interaction and minimize negative impacts.

- Reduce water-quality impacts on salmon from stormwater entering Lake Sammamish and the application of aquatic plant herbicides.

- Understand impact of degraded sediment quality on salmon in the Lake Sammamish system.

- Determine how altered trophic interactions in Lake Sammamish have an impact on the survival and reproduction of salmon; identify options to alleviate the impacts.

- Determine if late season lake stratification conditions impede fish migration through Lake Sammamish.

Tables 4-13 through 4-15 present near-term recommendations for the Lake Sammamish subarea. The tables are organized by action alternatives, potential projects, and research. Action alternatives are general recommendations for actions that should be taken to address an identified factor of decline. Potential projects are more specific on-the-ground opportunities that have been identified for applying an action alternative, such as replanting riparian vegetation at a specific location in a subarea. Research activities are designed to help scientists gain a better understanding of a subarea's factors of decline and to learn what roles the factors play and how to address them.

Table 4-13. Lake Sammamish Action Alternatives

Action Alternative No./Action Alternative	Factors of Decline Addressed	Projects Identified
Lake Sammamish AA 1		
Identify opportunities to protect and restore natural lake shorelines and shallow water habitat.	Degradation of riparian shoreline conditions	Lake Sammamish P 1
Lake Sammamish AA 2		
Identify opportunities to remove bank armoring and docks and to increase natural bank conditions. Construct demonstration projects on public lands or willing homeowners' property to remove bank armoring and construct soft erosion control systems.	Degradation of riparian shoreline conditions	No projects identified at this time
Lake Sammamish AA 3		
Reduce water-quality impact of stormwater entering lake. Identify opportunities to treat stormwater entering Lake Sammamish through biofiltration or other water-quality techniques. Consider experimental projects.	Poor water quality (temperature and nutrients)	No projects identified at this time
Lake Sammamish AA 4		
Identify, protect, and restore tributary mouths entering Lake Sammamish. Studies show that juvenile chinook hold and feed near the mouths of tributaries, even very small streams and drainages, during rearing and migration. In particular, state-owned land at the mouth of Issaquah Creek should be evaluated as a potential restoration site.	Degradation of riparian shoreline conditions	No projects identified at this time

Potential projects for the Lake Sammamish subarea are listed in the following table and can be located on Map 7. Each project has been assigned a number (P 1, P 2, etc.), and for projects that include more than one task, a letter has been assigned to each task (a, b, c, etc.). On the map, corresponding numbers and letters indicate the location of the project and task. For example, a

map point marked 2a refers to project 2, task a. Not all projects are mapped, because some are not being conducted in a specific location. Projects that are not mapped are noted in the table.

Table 4-14. Lake Sammamish Potential Projects

Project Name	Type of Project
Lake Sammamish P 1 Natural Shoreline Protection	**Protection**
The *Lake Sammamish Natural Shoreline Survey*, King County, Washington (The Watershed Company August 2000), identifies natural shoreline areas on Lake Sammamish that should be considered for protection, including: 1a Semi-natural shoreline north of Weber Point 1b Semi-natural shoreline between Weber Point and Inglewood Hills Road 1c Semi-natural shoreline between Weber Point and Inglewood Hills Road 1d Inglewood Hill shoreline at end of Inglewood Hills Road 1e Mallard Cove parcel just north of Sammamish State Park. If not included in the Watershed Company report cited above, survey and map shoreline for high-value wetlands, tributary mouths, and potential restoration sites and target for protection and restoration.	

Table 4-15. Lake Sammamish Research

Research	Research Description	Factors of Decline Addressed
Lake Sammamish R 1	Investigate natural history, behavioral ecology, and habitat preferences of juvenile chinook salmon in Lake Sammamish to help identify and evaluate habitat protection and restoration opportunities.	Degradation of riparian shoreline conditions
Lake Sammamish R 2	Experiment with alternative dock design/mitigation packages that use bank softening to replace docks and bank armoring.	Degradation of riparian shoreline conditions
Lake Sammamish R 3	Evaluate mouths of tributaries and small drainages for migration access for adults and rearing habitat for juveniles. Identify potential sites for either protection or restoration of mouths of tributaries and small drainages.	Degradation of riparian shoreline conditions
Lake Sammamish R 4	Evaluate whether further erosion control projects are required on Issaquah Creek and Tibbets Creek to reduce the introduction of phosphorus into the lake. In particular, the Interpace Mine site on Tibbets Creek should be evaluated. If it is determined that further erosion control projects are needed, projects should be designed and constructed.	Poor water quality (temperature and nutrients)
Lake Sammamish R 5	Study natural history, behavioral ecology, and habitat preferences of current fish populations in Lake Sammamish. Investigate how altered trophic interactions in Lake Sammamish system have an impact on salmon and identify options to alleviate the impact. If predation is determined to be a factor of decline based on the research described above, conduct controlled experiments in bass habitat minimization and reduction of bass populations in Lake Sammamish.	Altered trophic interactions

Research	Research Description	Factors of Decline Addressed
Lake Sammamish R 6	Investigate invasive aquatic plants/salmon interaction.	Invasive exotic plants
Lake Sammamish R 7	Research invasive aquatic weed management techniques to determine which methods are most effective and least harmful to aquatic animals.	Invasive exotic plants
Lake Sammamish R 8	Identify areas critical to juvenile and adult chinook migration for aquatic weed management; control invasive aquatic weeds in those parts of the lake.	Invasive exotic plants
Lake Sammamish R 9	Investigate sources of phosphorus, alkalinity, and pH increase as well as their possible effects on salmon in Lake Sammamish. Evaluate data to identify any possible trends in phosphorus, alkalinity, and pH increase (for example, seasonal; if seasonal, may be related to productivity).	Poor water quality
Lake Sammamish R 10	Sample key locations in Lake Sammamish (mouths of tributaries, shallow water habitat) for sediment contaminants. Evaluate potential impact on adult and juvenile salmon (ongoing King County assessment).	Poor sediment quality
Lake Sammamish R 11	Investigate the constraints on adult migration caused by stratification of temperature and dissolved oxygen in Lake Sammamish. Conduct field study to evaluate fish abundance and distribution during late-season lake stratification.	Fish access and passage barriers

Map 7. Lake Sammamish Subarea

Sammamish River

The Sammamish River corridor originates at the north end of Lake Sammamish and ends at the river mouth at the northern tip of Lake Washington. (See Map 8, Sammamish River Subarea.) The river itself drains a watershed of about 240 square miles, of which 97 square miles are in the Lake Sammamish basin, 50 miles are in the Bear Creek basin, 67 miles are in the combined basins of Little Bear Creek, Swamp Creek, and North Creek, and the remaining 26 miles are in small sidewall streams and the valley floor. The current river channel is 13.8 miles long. The Sammamish River has been significantly altered by human activities in the last 100 years, including the lowering of Lake Washington. In the 1960s, the river channel was deepened and straightened to increase its flood-flow capacity and to drain the surrounding wetlands for farming and development. The Sammamish River is primarily a migratory corridor for chinook, coho, sockeye, and kokanee salmon and steelhead trout that spawn in Issaquah Creek, Bear Creek, Little Bear Creek, North Creek, and Swamp Creek. Limited rearing of juvenile salmon may occur in the river.

The WRIA 8 Technical Committee identified the following factors of decline for the Sammamish River subarea: poor water quality (increased temperature, low dissolved oxygen, and contaminants); fish access and passage barriers; loss of channel complexity and connectivity; degradation of riparian conditions; altered hydrology and flow; and increased sedimentation and altered sediment transport processes.

The primary goal for the Sammamish River subarea is to protect and restore habitat-forming processes in the Sammamish River that will contribute to salmon recovery, including habitat conditions conducive to migration, rearing, and refuge areas.

The following objectives will help achieve this goal:

- Protect, restore, and create cold-water resources in the Sammamish River and its tributaries.
- Investigate alternative methods to address the impacts on salmon of increased temperatures in the Sammamish River.
- Improve fish access to the Sammamish River's tributaries.
- Enhance channel complexity, floodplain connectivity, and riparian conditions.
- Decrease surface and groundwater withdrawals that reduce river flow and groundwater seeps; maintain a more natural hydrologic regime.
- Reduce runoff and fine sediments entering the river.

- Understand and reduce the impact of low dissolved oxygen and contaminants on salmon in the Sammamish River.

Tables 4-16 through 4-18 present near-term recommendations for the Sammamish River subarea. The tables are organized by action alternatives, potential projects, and research. Action alternatives are general recommendations for actions that should be taken to address an identified factor of decline. Potential projects are more specific on-the-ground opportunities that have been identified for applying an action alternative, such as replanting riparian vegetation at a specific location in a subarea. Research activities are designed to help scientists gain a better understanding of a subarea's factors of decline and to learn what roles the factors play, and how to address them.

Table 4-16. Sammamish River Action Alternatives

Action Alternative No./Action Alternative	Factors of Decline Addressed	Projects Identified
Sammamish River AA 1		
Identify opportunities to provide cool water refuge areas on the river, especially at tributary confluences and locations of significant groundwater inflows.	Poor water quality (increased temperature) Loss of channel complexity and connectivity	Sammamish River P 2, 3, 4, 13
Sammamish River AA 2		
Identify opportunities to slope back streambanks. Create flood benches at or below ordinary high-water mark of the river to increase shallow water habitats used by juvenile salmon.	Poor water quality (increased temperature) Loss of channel complexity and connectivity Degradation of riparian conditions	Sammamish River P 7, 12
Sammamish River AA 3		
Restore riparian areas throughout the entire Sammamish River corridor. Identify opportunities to plant early successional riparian vegetation to provide shade on the mainstem river, particularly at the upper end of the river.	Degradation of riparian conditions Poor water quality (increased temperature)	Sammamish River P 5, 6, 11
Sammamish River AA 4		
Identify opportunities to improve fish access through the Sammamish River system, including access to the Sammamish River tributaries and at the weir. King County Road Maintenance is currently identifying and prioritizing fish passage barriers in the road right-of-way in unincorporated King County. This may generate additional fish passage improvement projects in the Sammamish River system. Also see Action Alternative regarding the creation of cold-water refuges at tributary mouths.	Fish access and passage barriers	Sammamish River P 13

Action Alternative No./Action Alternative	Factors of Decline Addressed	Projects Identified
Sammamish River AA 5		
Identify and evaluate opportunities to reconnect existing wetlands to old oxbows and side channels, and to create off-channel, riparian wetland areas. A recent report funded by King county should help identify opportunities: *Wetlands Functions Assessment Sammamish River Sub-basin* (Shannon & Wilson, Inc. March 2002).	Loss of channel complexity and connectivity Degradation of riparian conditions	Sammamish River P 14, 15
Sammamish River AA 6		
Identify opportunities to reduce contaminants and runoff entering river.	Poor water quality (low dissolved oxygen, contaminants)	Sammamish River P 8
Sammamish River AA 7		
Identify opportunities to protect existing high-value habitats and areas that have a strong likelihood of restoration success.	Loss of channel complexity/ connectivity Degradation of riparian conditions	Sammamish River P 9, 10
Sammamish River AA 8		
Identify opportunities to create new pools and to enhance deeper areas in the river used by migrating adult salmon as holding or staging areas.	Loss of channel complexity/ connectivity	Sammamish River P 2, 3, 4, 7
Sammamish River AA 9		
Identify opportunities to reduce surface water and groundwater withdrawals from tributaries to the river.	Poor water quality (increased temperature)	Sammamish River P 1
Sammamish River AA 10		
Identify opportunities to maintain and enhance headwater wetlands and forested hill slopes on all significant tributaries to the river in order to protect the river's current thermal regime.	Poor water quality (increased temperature) Loss of channel complexity and connectivity Degradation of riparian conditions	No projects identified at this time

Potential projects for the Sammamish River subarea are listed in the following table and can be located on Map 8. Each project has been assigned a number (P 1, P 2, etc.), and for projects that include more than one task, a letter has been assigned to each task (a, b, c, etc.). On the map, corresponding numbers and letters indicate the location of the project and task. For example, a map point marked 2a refers to project 2, task a. Not all projects are mapped, because some are not being conducted in a specific location. Projects that are not mapped are noted in the table.

Table 4-17. Sammamish River Potential Projects

Project Name	Type of Project
Sammamish River P 1 Reclaimed Water Pilot Project (not mapped)	**Reduction of Water Withdrawals**
Work with Central Puget Sound Water Suppliers Forum and King County reclaimed water program to allocate regional water supplies to replace surface and shallow groundwater withdrawals. Prioritize withdrawals in Sammamish tributaries and mainstem for reallocation discussions. Implement regional pilot for reclaimed water program in Sammamish Valley.	
Sammamish River P 2 Lower Bear Creek Floodplain and Channel Restoration	**Restoration**
As identified in *Sammamish River Corridor Action Plan* (Tetra Tech Inc. Infrastructure Services Group 2002*)*, restore lower 2/3 mile of Bear Creek to its confluence with the river. This process will include placement of large woody debris in the river upstream of the confluence to create a cold-water refuge pool and delay mixing of warm river water with much cooler water from Bear Creek.	
Sammamish River P 3 Norway Hills Enhancement	**Restoration**
Evaluate creation of pools in the Norway Hill area of the river where some groundwater sources are piped to the river as part of the stormwater system. Determine if groundwater inflows at Norway Hill are in need of special protection or mitigation.	
Sammamish River P 4 Creation and Enhancement of Pools as Cool Water Refuges for Migrating Adult Salmon (not mapped)	**Restoration**
Evaluate creation of new pools in areas where there are long gaps between pools. The *Sammamish River Corridor Action Plan* identifies the following locations: between RM 0.8 and 2.3, RM 3.9 and 5.6, RM 6.1 and 7.1, and RM 7.5 and 9.0. Evaluate the enhancement of existing deeper areas, particularly in the upper river. All pools should take advantage of cool-water sources wherever possible, including tributaries and groundwater inflows, using large woody debris to create areas of localized scour, inhibit mixing of cool water inputs with warm river water, and provide cover.	
Sammamish River P 5 Upper River Riparian Restoration (not mapped)	**Restoration**
Evaluate restoration of riparian area in the 11 miles of the river between Marymoor Park in Redmond and Blyth Park in Bothell. Property is all under public ownership, and future plans for a second trail near this section of river would provide good opportunities for riparian restoration.	
Sammamish River P 6 Revision of Levee Maintenance Practices (not mapped)	**Revegetation**
Work with U.S. Army Corps of Engineers to revise maintenance practices on Sammamish River banks and levees in order to improve and restore salmon habitat functions. 6a Apply results of Corps' consultation with National Marine Fisheries Service on maintenance of flood control structures. 6b Evaluate request for deactivation or de-authorization of Sammamish River flood control project so that restoration can occur without meeting Corps' levee requirements. In the event that the project is not deactivated or de-authorized, restoration projects should be designed to compensate for lost flood storage.	
Sammamish River P 7 Marymoor Re-Meander	**Fish Passage Improvement**
Restore left meander of river downstream of Lake Sammamish weir, including creation of pools at meander bends and construction of overflow bench with wetland vegetation. Restoration will need to meet U.S. Army Corps of Engineers requirements for channel conveyance to minimize flood risks to lakeshore properties.	

Project Name	Type of Project
Sammamish River P 8 Program to Implement Best Management Practices (not mapped)	**Best Management Practices**
Work with property owners along the river to implement best management practices that minimize the use of chemicals suspected of harming aquatic life. Initial focus of program could be on Wayne, Willows Run, and Inglewood Country Club golf courses, farms in the agricultural production district, and residential communities that abut the river.	
Sammamish River P 9 Acquire Undeveloped Property at Mouth of Swamp Creek	**Protection**
Purchase parcel to the east of Swamp Creek Regional Park for inclusion in Project 15 Swamp Creek Regional Park Wetland and Stream Restoration.	
Sammamish River P 10 Acquire Former Channel Meander Across from Willows Run Golf Course	**Protection**
Acquire 80-acre parcel on right bank across from Willows Run Golf Course that is the site of a former channel meander, for floodplain and wetland restoration.	
Sammamish River P 11 Riparian Plantings (not mapped)	**Revegetation**
Continue and expand projects such as Sammamish Re-Leaf and Redmond Riverwalk to plant early successional riparian vegetation to provide shade.	
Sammamish River P 12 Regrade Banks and Create Flood Benches (not mapped)	**Restoration**
The *Sammamish River Corridor Action Plan* describes opportunities to regrade banks, create flood benches at or below high-water mark, and plant banks and benches with native vegetation. Particular focus should be given to the upper river (RM 11 to RM 13.6) and downstream of the major tributaries.	
Sammamish River P 13 Enhance Tributary Confluences	**Restoration**
Enhance tributary confluences with Sammamish River, including correction of fish passage barriers, riparian restoration, placement of large woody debris, and creation of cool-water refuge areas. Locations identified in the *Sammamish River Corridor Action Plan* include: 13a Tributary 0068 13b Tributary 0095 13c Tributary 0101 13d Tributary 0104 13e Gold Creek 13f Woodin Creek 13g Derby Creek. It should be noted that all tributary confluences are candidates for improvements.	
Sammamish River P 14 Enhance and Reconnect Riparian Wetlands	**Restoration**
Enhance and reconnect riparian wetlands to river, as described in the *Sammamish River Corridor Action Plan*, including: 14a Wildcliff Shores, across from Swamp Creek 14b Wetland and remnant side channels adjacent to 102nd Avenue bridge 14c Publicly owned historic wetland areas adjacent to I-405/SR 522 interchange 14d Historic wetland and meander area near Gold Creek 14e Wetlands in and across from Willows Run Golf Course.	

Project Name	Type of Project
Sammamish River P 15 Swamp Creek Regional Park Wetland and Stream Restoration	**Restoration**
As identified in the *Sammamish River Corridor Action Plan*, restore large, publicly owned wetland complex at the confluence of Swamp Creek and the Sammamish River, creating a diversity of wetland elevations and habitats in the floodplain.	

Table 4-18. Sammamish River Research

Research	Research Description	Factors of Decline Addressed
Sammamish River R 1	Evaluate Cold Creek (tributary to Bear Creek) groundwater system and identify strategy to protect its cold-water resources.	Poor water quality (increased temperature)
Sammamish River R 2	Examine how altered temperatures in the Sammamish River affect the migration and reproductive success of adult salmon and the use of habitat and mortality rates of juvenile salmon.	Poor water quality (increased temperature)
Sammamish River R 3	Study how groundwater flows affect the temperature and hydrology of the river. Determine the location, volume, and water quality of groundwater flows into the river, particularly upstream of North Creek. Evaluate what the effect would be of eliminating some or all of the current groundwater withdrawals from the river, and of using reclaimed water to recharge aquifers (ongoing King County and U.S. Army Corps of Engineers study).	Poor water quality (increased temperature)
Sammamish River R 4	Investigate ways to reduce water temperatures in the Sammamish River, including more experimental, engineered methods such as pumping water from bottom of Lake Sammamish to the weir and installing cooling towers.	Poor water quality (increased temperature)
Sammamish River R 5	Evaluate restoration sites on the river against baseline conditions and each other as well as for effects on juvenile rearing conditions and predation. Modify new site designs based on results.	Loss of channel complexity and connectivity Degradation of riparian conditions
Sammamish River R 6	Conduct predator studies of the Sammamish River and evaluate adult and juvenile salmon use of habitat to assist in identifying habitat restoration opportunities and improving design of habitat restoration projects (ongoing through King County and the U.S. Army Corps of Engineers).	Loss of channel complexity and connectivity Degradation of riparian conditions
Sammamish River R 7	Examine water and sediment quality for conditions that could have sublethal effects on salmon (ongoing through King County).	Poor water quality (low dissolved oxygen, contaminants)
Sammamish River R 8	In areas of measurable heating, collect temperature data at key locations of Swamp Creek, North Creek, Little Bear Creek, and Bear Creek. Identify alternatives for maintaining cooler temperatures.	Poor water quality (increased temperatures)

Research	Research Description	Factors of Decline Addressed
Sammamish River R 9	Update Sammamish River flood conveyance model to incorporate expected changes resulting from the implementation of projects along river corridor. Will be critical for designing riparian and channel restoration projects.	Loss of channel complexity and connectivity
Sammamish River R 10	Identify and prioritize removal of fish passage barriers, based on quality and area of habitat upstream, species likely to use habitat, functions, and processes likely to be restored, cost, and other factors.	Fish passage barriers

Map 8. Sammamish River Subarea

Cedar River and Chinook-Bearing Tributaries

The Cedar River is the largest tributary to Lake Washington and drains an elongated basin of 188 square miles that extends from the crest of the Cascade Mountains to the southern shore of Lake Washington in the City of Renton. (See Maps 9a and 9b, Cedar River Subarea – Lower and Upper.) The upper two-thirds of the subarea is owned and managed by the City of Seattle and supplies drinking water to two-thirds of Seattle and its regional customers. The Cedar River Municipal Watershed is almost entirely coniferous forest, and its management is governed by the Cedar River Watershed Habitat Conservation Plan. The lower third of the Cedar River subarea below the Landsburg Diversion Dam includes 21 miles of mainstem river and 15 tributaries, and drains a 66-square-mile area. The lower Cedar River mainstem and four main fish-bearing tributaries provide the majority of the current spawning habitat for chinook and sockeye salmon and steelhead trout in the WRIA 8 system as well as significant spawning and rearing habitat for coho salmon and cutthroat trout. The following tributaries support chinook: Lower Rock Creek, Walsh Lake Diversion, Peterson Creek, and Taylor Creek. Of particular note: The Cedar River's chinook population is one of the native stocks that comprise the evolutionarily significant unit of Puget Sound chinook salmon, which is listed as threatened under the Endangered Species Act. Most of the lower Cedar River subarea is rural and forested, except for the cities of Renton and Maple Valley, where the subarea is urbanized.

The WRIA 8 Technical Committee identified the following factors of decline for the Cedar River and its chinook-bearing tributaries:

- **Mainstem factors of decline:** fish access and passage barriers; loss of channel complexity and connectivity; degradation of riparian conditions; increased sedimentation and altered sediment transport processes; and altered hydrology and flow
- **Chinook-bearing tributaries factors of decline:** altered hydrology and flow (Lower Rock, Walsh, Taylor, Peterson), fish access and passage barriers (Lower Rock, Walsh, Taylor, Peterson); channel complexity and connectivity (Walsh, Taylor, Peterson); degraded riparian condition (Lower Rock, Taylor, Peterson); and increased sedimentation and altered sediment transport processes (Walsh, Peterson).

Because of a unique stock of chinook in the Cedar River subarea, the primary goal for the subarea is to protect and restore the ecosystem processes and geomorphic conditions to which this stock has naturally adapted. These habitat conditions allow spawning, rearing, refuge areas, and migration.

The following objectives will help achieve this goal:

- Allow for unimpeded fish access to all potential spawning and rearing habitats.
- Protect the best remaining habitat and prevent degradation of existing high-quality habitat.

- Protect, reconnect and/or restore off-channel habitat and shallow, mainstem habitat.
- Protect and, where feasible, restore floodplain connectivity throughout the Cedar River subarea.
- Remove bank hardening and existing structures in the floodplain and prevent additional bank hardening.
- Protect and restore in-stream channel complexity and functional riparian conditions.
- Ensure the adequate and continual supply of suitable spawning substrate throughout the system.
- Reduce forest road runoff and fine sediments entering the mainstem and its tributaries.
- Protect and maintain flows in the mainstem and tributaries to provide suitable rearing, spawning, and migratory habitats for all salmon species.

Tables 4-19 through 4-21 present near-term recommendations for the Cedar River subarea. The tables are organized by action alternatives, potential projects, and research. Action alternatives are general recommendations for actions that should be taken to address an identified factor of decline. Potential projects are more specific on-the-ground opportunities that have been identified for applying an action alternative, such as replanting riparian vegetation at a specific location in a subarea. Research activities are designed to help scientists gain a better understanding of a subarea's factors of decline and to learn what roles the factors play and how to address them.

Table 4-19. Cedar River Action Alternatives

Action Alternative No./Action Alternative	Factors of Decline Addressed	Projects Identified
Cedar River AA 1		
Identify all physical, hydrological, chemical, and biological barriers to fish migration and provide access. King County Road Maintenance is currently identifying and prioritizing fish passage barriers in the road right-of-way in unincorporated King County. This may generate additional fish passage improvement projects in the tributaries to the Cedar River.	Fish access and passage barriers	Cedar River P 1, 2, 3
Cedar River AA 2		
Identify and protect the best remaining habitat and prevent degradation of existing high-quality habitat.	Loss of channel complexity and connectivity Degradation of riparian conditions	Cedar River P 4, 5

Action Alternative No./Action Alternative	Factors of Decline Addressed	Projects Identified
Cedar River AA 3		
Retain forest cover in the Cedar River subarea to the greatest extent possible. The *Lower Cedar River Basin and Nonpoint Pollution Action Plan* (King County July 1998) set a goal of retaining a minimum of 65 percent forest cover in the Lower Cedar River and rural salmon-bearing tributaries (Walsh Lake Diversion, Rock Creek, Peterson Creek, and Taylor Creek) to protect the hydrologic regime of the Cedar River. Identify opportunities to reduce impervious areas and convert grass areas to a forested landscape.	Altered hydrology and flow	Cedar River P 6
Cedar River AA 4		
Identify opportunities to reconnect potential or marginally functioning off-channel habitat or create new off-channel habitat and shallow mainstem habitat.	Loss of channel complexity and connectivity Degradation of riparian conditions	Cedar River P 7
Cedar River AA 5		
Identify opportunities to remove bank hardening and existing structures in the floodplain.	Loss of channel complexity and connectivity Degradation of riparian conditions	Cedar River P 8
Cedar River AA 6		
Maintain existing large woody debris and large woody debris complexes where possible. Identify opportunities to safely increase large woody debris in the system. Re-establish natural large woody debris recruitment processes.	Loss of channel complexity and connectivity Degradation of riparian conditions	Cedar River P 9
Cedar River AA 7		
Identify opportunities to restore riparian conditions on the Cedar River and its chinook-bearing tributaries, such as ongoing re-vegetation projects at Cavanaugh Pond and the Renton Lions Club property. Identify opportunities to remove non-native invasive plants and replant native vegetation.	Loss of channel complexity and connectivity; Degradation of riparian conditions	Cedar River P 10
Cedar River AA 8		
Decommission or improve forest roads in the Cedar River Municipal Watershed in order to reduce runoff and prevent fine sediments from entering the Cedar River and its tributaries. For more details on forest roads to be decommissioned or improved, see the *Final Cedar River Watershed Habitat Conservation Plan* (City of Seattle 2000).	Increased sedimentation and altered sediment transport processes	Cedar River P 11, 12

Potential projects for the Cedar River subarea are listed in the following table and can be located on Maps 9a and 9b (Cedar River – Lower and Cedar River – Upper). Each project has been assigned a number (P 1, P 2, etc.), and for projects that include more than one task, a letter has been assigned to each task (a, b, c, etc.). On the map, corresponding numbers and letters indicate the location of the project and task. For example, a map point marked 2a refers to project 2, task a. Not all projects are mapped, because some are not being conducted in a specific location. Projects that are not mapped are noted in the table.

Table 4-20. Cedar River Potential Projects

Project Name	Type of Project
Cedar River P 1 Fish Ladder at Landsburg	**Fish Passage**
The Landsburg Diversion Dam blocks fish access to the Cedar River Municipal Watershed. The City of Seattle will complete construction of a fish ladder at Landsburg in 2003, which will open 12 miles of mainstem habitat and approximately 5 miles of tributary habitat to all salmon species except sockeye.	
Cedar River P 2 Lighting Decrease Near Mouth	**Fish Passage**
Reduce lighting near Cedar River mouth to reduce predation of juvenile salmon and improve their passage into Lake Washington.	
Cedar River P 3 Fish Passage Improvement on Forest Roads (not mapped)	**Fish Passage**
The *Final Cedar River Watershed Habitat Conservation Plan* has identified structures at forest road stream crossings in Seattle's Cedar River Municipal Watershed that impede fish passage (primarily culverts). Starting in 2001, these structures will be removed, upgraded, or replaced to restore passage for anadromous fish, bull trout, and other resident fish.	
Cedar River P 4 Habitat Reaches to Be Protected	**Protection**
Continue Cedar River Legacy habitat program to protect best remaining habitat through acquisition, easements, or tax breaks. The following mainstem reaches have been targeted for protection by the Cedar River Legacy Program: 4a Belmondo Reach 4b 218th Place Side Channel Reach 4c Landsburg Reach 4d Lower Dorre Don Left Bank Meander Reach 4e Ricardi Reach 4f Dorre Don Meanders Reach 4g Lower Lions Stream Reach 4h Mouth of Lower Taylor Creek Reach 4i Jones Reach 4j Byers Reach. There are four chinook-bearing tributaries in the Lower Cedar River: Rock Creek, Walsh Lake Diversion, Peterson Creek, and Taylor Creek. The following tributary reaches have been targeted for protection by the Cedar River Legacy Program: 4k Rock Creek Natural Area Addition 4l Rock Creek Ravensdale Retreat 4m North Fork Taylor Creek – Upper Maxwell 4n Lower Peterson Creek.	
Cedar River P 5 Habitat Management Plans for Protected Properties (not mapped)	**Habitat Management**
Develop habitat-based management and use guidelines for properties that have been acquired for habitat protection.	
Cedar River P 6 Forest Protection in Municipal Watershed (not mapped)	**Forest Management**
Preserve all riparian and upland forest (including old growth) in the Cedar River Municipal Watershed in order to protect natural processes and habitat quality in the river, its tributaries, and its wetlands.	

Project Name	Type of Project

Cedar River P 7 Projects to Restore/Enhance Off-Channel Habitat — **Restoration/Enhancement**

The following projects are examples of identified opportunities to create, enhance, or restore off-channel habitat. There are more potential projects to improve off-channel habitat identified in Appendix E of the *Lower Cedar River Basin and Nonpoint Pollution Action Plan*. This list represents King County staff recommendations for projects to pursue in the near term and are subject to change, depending on funding, landowner cooperation, and other feasibility factors.

- 7a Buck's Curve buyout and restoration, and Jones Road levee setback
- 7b Groundwater-fed channel behind Herzman levee
- 7c Partial removal of Jan Road levee
- 7d Getchman levee setback and reconnection of natural channel
- 7e Reconnection of Wetland 69, an oxbow wetland, to the Cedar River
- 7f Lion's Club pond and channel project
- 7g Byer's Reach side channel
- 7h 218th Place side channel enhancement
- 7i Dorre Don Meanders side channel
- 7j Ricardi Reach restoration
- 7k Identification of opportunities to restore or enhance off-channel habitat along initial mile of chinook-bearing tributary systems.

Cedar River P 8 Projects to Maintain and Restore Floodplain Connectivity — **Restoration/Enhancement**

The following projects are examples of identified opportunities to remove existing structures in the floodplain and increase floodplain connectivity. There are more potential projects identified in the *Lower Cedar River Basin and Nonpoint Pollution Action*. This list represents King County staff recommendations for projects to pursue in the near term and could change depending on funding, landowner cooperation and other feasibility factors. There is some overlap with projects listed above to restore off-channel habitat because the projects meet both objectives.

Mainstem projects:

- 8a Ricardi levee removal (previous flood buyout)
- 8b Getchman levee setback and reconnection of natural channel
- 8c Cedar Grove Road full levee removal (previous flood buyout and partial removal already occurred)
- 8d Buck's Curve flood buyout, road setback, and levee removal
- 8e Pursuit of additional buyouts near McDonald levee
- 8f Cedar Grove Mobile Home Park flood buyout and levee removal
- 8g Rutledge Johnson downstream end levee removal
- 8h Cedar Mountain revetment removal
- 8i Cedar Grove road junkyard buyout
- 8j Dorre Don area flood buyouts
- 8k River Bend Mobile Home Park buyout
- 8l Identification of opportunities, such as ongoing Taylor Creek project, to remove bank hardening and structures in the floodplain along initial mile of chinook-bearing tributaries. (not mapped)

Cedar River P 9 Passage of Large Woody Debris Over Landsburg Dam — **Increase Large Woody Debris**

Request that the City of Seattle consider passing large woody debris over Landsburg Dam as appropriate.

Cedar River P 10 Riparian Forest Restoration in Upper Watershed (not mapped) — **Forest Restoration**

Starting in 2001, identify, prioritize, and accelerate natural restoration of about 45 acres per year of degraded riparian forest in the Cedar River Municipal Watershed.

Project Name	Type of Project
Cedar River P 11 Road Decommissioning in Upper Watershed (not mapped)	**Forest Road Removal**
Starting in 2001, decommission about 10 miles of forest roads per year in the Cedar River Municipal Watershed.	
Cedar River P 12 Forest Road Drainage Improvements (not mapped)	**Forest Road Improvements**
Starting in 2001, improve drainage (to adjacent forest floor) on approximately 7 miles of existing forest roads per year in the Cedar River Municipal Watershed.	
Cedar River P 13 Projects to Restore Riparian Conditions	**Restoration**
Restore riparian conditions in Rock Creek Cemetery Reach through removal of non-native species and planting of native vegetation.	

Table 4-21. Cedar River Research

Research No.	Research Description	Factors of Decline Addressed
Cedar River R 1	Update *Lower Cedar River Basin and Nonpoint Pollution Action Plan* inventory of fish access barriers on Cedar River tributaries and prioritize barrier removals for implementation. In particular, consider feasibility of fish passage improvements on chinook-bearing tributaries where potential fish barriers have been identified (Rock, Taylor, Walsh, Peterson).	Fish access and passage barriers
Cedar River R 2	Conduct feasibility studies of potential projects to create, reconnect, or restore off-channel habitat on the Cedar River mainstem and chinook-bearing tributaries utilizing Appendix E of *Lower Cedar River Basin and Nonpoint Pollution Action Plan.*	Loss of channel complexity and connectivity Degradation of riparian conditions
Cedar River R 3	Investigate opportunities to increase riparian vegetation, shallow water, and off-channel habitat in the lowest reach of the Cedar River through Renton, at the mouth, and on south Lake Washington adjacent to the mouth.	Loss of channel complexity and connectivity Degradation of riparian conditions
Cedar River R 4	Identify and map hardening of privately owned riverfront property in the Cedar River subarea in order to identify opportunities to soften or remove additional bank hardening.	Loss of channel complexity and connectivity Degradation of riparian conditions
Cedar River R 5	Monitor existing restoration projects incorporating large woody debris and natural large woody debris functions in Cedar River to improve future restoration project designs.	Loss of channel complexity and connectivity Degradation of riparian conditions
Cedar River R 6	Evaluate gravel quality, quantity, and transport on the Cedar River mainstem, including the effect of bank armoring, to determine if gravel supply is limiting to salmon spawning. (Ongoing study by U.S. Army Corps of Engineers, cities of Seattle and Renton, and King County.) If gravel supply is determined to limit spawning, identify locations where natural bank erosion and gravel recruitment could be enhanced or reestablished and, if needed, initiate gravel supplementation project.	Increased sedimentation and altered sediment transport processes

Research No.	Research Description	Factors of Decline Addressed
Cedar River R 7	Work with City of Kent to investigate ways to increase Lower Rock Creek instream flows, including, but not limited to, replacing lost water supply. City of Kent flow studies should be helpful in this investigation.	Altered hydrology and flow
Cedar River R 8	Investigate influence of altered flow regime for impacts on salmon habitat and survival. Work to be done jointly between the Flow Subcommittee of the WRIA 8 Technical Committee and the Cedar River Instream Flow Commission to evaluate benefits and impacts of managed flow regimes on salmon habitat and survival in the Cedar River.	Altered hydrology and flow
Cedar River R 9	Conduct comprehensive study of the ecological benefits to salmon of reconnecting the Walsh Lake Diversion to its historical conjunction with Upper Rock Creek vs. enhancing of the current Walsh Lake Diversion.	Altered hydrology and flow Fish access and passage barriers Loss of channel complexity and connectivity Increased sedimentation and altered sediment transport processes
Cedar River R 10	Evaluate the impact of predation on the survival of juvenile chinook salmon.	Altered hydrology and flow Fish access and passage barriers Loss of channel complexity and connectivity Increased sedimentation and altered sediment transport processes
Cedar River R 11	Continue ongoing juvenile salmon out-migration studies for the Cedar River.	Altered hydrology and flow Fish access and passage barriers Loss of channel complexity and connectivity Increased sedimentation and altered sediment transport processes

Map 9a. Cedar River Subarea – Lower

Map 9b. Cedar River Subarea – Upper

Bear Creek and Chinook-Bearing Tributaries

The Bear Creek subarea covers approximately 32,100 acres or 50 square miles. (See Map 10, Bear Creek Subarea.) The subarea is located in southern Snohomish County and northern King County and is composed of three main tributaries: Bear Creek, Cottage Lake Creek, and Evans Creek. Bear Creek empties into the Sammamish River in the City of Redmond. Both Bear Creek and Cottage Lake Creek provide excellent spawning and rearing habitat for chinook, coho, sockeye, and kokanee salmon and steelhead trout.

The WRIA 8 Technical Committee identified the following factors of decline for the Bear Creek subarea: fish access and passage barriers; loss of channel complexity and connectivity; altered hydrology and flow; increased sedimentation and altered sediment transport processes; poor water quality (increased temperature and nutrients); and degradation of riparian condition.

The primary goal for the Bear Creek subarea is to protect and restore salmon habitat and habitat-forming processes in Bear Creek that contribute to the life cycle requirements of adult and juvenile salmon for spawning, rearing, and migration.

The following objectives will help achieve this goal:

- Allow for unimpeded access to all potential natural spawning and rearing habitats for all life stages of salmon throughout the Bear Creek subarea.
- Protect the best remaining habitat and prevent degradation of existing high-quality habitat.
- Protect and restore channel complexity and floodplain connectivity.
- Protect and maintain flows and hydrologic regime in Bear Creek and its tributaries.
- Identify, protect, and restore cold-water resources in Bear Creek and its tributaries.
- Protect and restore riparian conditions.
- Reduce runoff and fine sediments entering Bear Creek.
- Understand and reduce impact of elevated nutrients in Bear Creek.

Tables 4-22 through 4-24 present near-term recommendations for the Bear Creek subarea. The tables are organized by action alternatives, potential projects, and research. Action alternatives are general recommendations for actions that should be taken to address an identified factor of decline. Potential projects are more specific on-the-ground opportunities that have been identified for applying an action alternative, such as replanting riparian vegetation at a specific location in a subarea. Research activities are designed to help scientists gain a better understanding of a subarea's factors of decline and to learn what roles the factors play and how to address them.

Table 4-22. Bear Creek Action Alternatives

Action Alternative No./Alternative	Factors of Decline Addressed	Projects Identified
Bear Creek AA 1		
Restore fish access at identified fish access and passage barriers. King County Road Maintenance is currently identifying and prioritizing fish passage barriers in the road right-of-way in unincorporated King County. This may generate additional fish passage improvement projects in the Bear Creek subarea.	Fish access and passage barriers	Bear Creek P 1, 2
Bear Creek AA 2		
Identify opportunities to increase channel complexity and connectivity.	Loss of channel complexity and connectivity	Bear Creek P 3, 4, 5
Bear Creek AA 3		
Identify opportunities to protect and maintain flows and hydrologic regime in Bear Creek and its tributaries, such as acquiring water rights and pursuing agreements to change water withdrawal timing to reduce impacts on salmon.	Altered hydrology and flow	Bear Creek P 6
Bear Creek AA 4		
Retain forest cover in the Bear Creek subarea to the extent possible. The *Bear Creek Basin Plan* (King County 1990) sets a goal of retaining a minimum of 65 percent forest cover to protect the hydrologic regime. Identify opportunities to reduce effective impervious areas and convert grass areas to a forested landscape.	Altered hydrology and flow	Bear Creek P 7
Bear Creek AA 5		
Identify opportunities to reduce runoff and fine sediments entering Bear Creek.	Increased sedimentation and altered sediment transport processes	No projects identified at this time
Bear Creek AA 6		
Identify and protect best remaining habitat and prevent degradation of existing high-quality habitat.	Degradation of riparian condition	Bear Creek P 8
Bear Creek AA 7		
Identify opportunities to restore riparian conditions by planting native coniferous trees and removing invasive non-native plants in the riparian zones throughout the subarea. First priority for riparian restoration should be the mainstems of Bear Creek and Cottage Lake Creek. Reduce invasive non-native plants in reaches used by chinook salmon (particularly reed canarygrass and purple loosestrife in lower Evans Creek).	Degraded riparian conditions Poor water quality (increased temperatures)	Bear Creek P 9
Bear Creek AA 8		
Identify opportunities to retrofit old (pre-1998) stormwater retention/detention facilities to better retain, release, treat, and infiltrate stormwater.	Altered hydrology and flow Poor water quality	No projects identified at this time

Potential projects for the Bear Creek subarea are listed in the following table and can be located on Map 10. Each project has been assigned a number (P 1, P 2, etc.), and for projects that include more than one task, a letter has been assigned to each task (a, b, c, etc.). On the map, corresponding numbers and letters indicate the location of the project and task. For example, a map point marked 2a refers to project 2, task a. Not all projects are mapped, because some are not being conducted in a specific location. Projects that are not mapped are noted in the table.

Table 4-23. Bear Creek Potential Projects

Project Name	Type of Project
Bear Creek P 1 Fish Passage Project Benefiting All Species (Including Chinook)	**Fish Passage**
Assess and propose project(s) to deal with potential biological access barrier for chinook salmon caused by choking reed canarygrass in Evans Creek (08-0106)[a] from RM 1.25 to 5.25.	
Bear Creek P 2 Fish Passage Projects Benefiting Other Species	**Fish Passage**
Restore fish passage to benefit coho and kokanee salmon and cutthroat and steelhead trout, in order of priority based on habitat made available by the elimination of barriers:	
2a Passage over Welcome Lake Dam on Colin Creek (08-0132)	
2b Passage over dam on Siedel Creek (08-0129) in Redmond Watershed Preserve	
2c Passage under Union Hill Road NE on tributary (08-0108)	
2d Passage through culvert on Rutherford Creek (08-0110) at NE 60th Street	
2e Passage over private dam on Rutherford Creek (08-0110) on the north side of Union Hill Road NE	
2f Passage over private dam on tributary (08-0122A) just west of Avondale Road NE at about NE 144th Street	
2g Passage under 216th Avenue NE on Struve Creek (08-0131)	
2h Passage under NE 145th Street on unmapped tributary of Bear Creek just west of Bear Creek and just upstream of Bear Creek confluence	
2i Passage under private driveway downstream of and under 238th Avenue NE on tributary to Evans Creek (08-0106) near NE 70th Street	
2j Passage under private driveway on tributary (08-0111A) of Evans Creek near NE 31st Street	
2k Improvement of passage under Woodinville Duvall Road NE on tributary (08-0127) at Cottage Lake County Park	
2l Passage over private dam on tributary (08-0120) just upstream of confluence with Bear Creek	
2m Passage over private dam on tributary (08-0119) north of NE 116th Street at about 177th Avenue NE	
2n Passage over private dam on tributary (08-0119) north of NE 116th Street at about 177th Avenue NE.	
Bear Creek P 3 Addition of Large Woody Debris to Cottage Lake and Bear Creeks	**Restoration**
Install large woody debris in Cottage Lake Creek from the confluence with Bear Creek upstream to NE 165th Street and in Bear Creek where needed from Woodinville-Duvall Road downstream to the Sammamish River.	
Bear Creek P 4 Lower Bear Creek Restoration	**Restoration**
Provide an enhanced channel alternative to the ditched and leveed lower 3,000 feet of Bear Creek, including a new refuge confluence with the Sammamish River.	
Bear Creek P 5 Evans/Bear Creek Restoration	**Restoration**
In-channel restoration is needed in Bear Creek and Evans Creek through the former dairy farm at the confluence; RM 1.5 to RM 2.5 on Bear Creek and RM 1.2 to RM 4.6 on Evans Creek.	

Project Name	Type of Project
Bear Creek P 6 Cold Creek Protection	**Protection**
Determine the source of, and properly protect, the aquifer for the Cold Creek groundwater springs in Cottage Lake Creek.	
Bear Creek P 7 Forest Cover Protection	**Protection**
Acquire forest property, development rights/conservation easements, and provide enhanced incentives to retain and plant forest area environments. In particular, acquire fee interests or conservation easements in Snohomish County on forested headwaters of Cottage Lake Creek and Bear Creek (700 acres in four ownerships).	
Bear Creek P 8 Bear Creek Waterways	**Protection**
Continue the Waterways 2000 protection and restoration program in the Bear Creek subarea. 8a Cottage Lake Creek at the 40-acre parcel at RM 1.25 (both protection and restoration) 8b Cold Creek headwaters area 8c Bear Creek Waterways reaches A, B, and D Expand the original program into Snohomish County. 8d Snohomish County Bear Creek headwaters in Paradise Valley Protect creek buffers that meet Waterways 2000 criteria but are located outside the original designated reaches. 8e Riparian forested buffers along Bear Creek, Cottage Lake Creek, and other salmonid tributaries (for example, the Stensland/Tharp parcel).	
Bear Creek P 9 Bear and Evan Creeks Greenway Project	**Protection/Restoration**
Continue Bear and Evans Creeks Greenway project to protect and restore key riparian lands, particularly the former dairy farm at the confluence of Bear and Evans creeks (City of Redmond project).	

[a] Washington Department of Fish and Wildlife stream designation

Table 4-24. Bear Creek Research

Research No.	Research Description	Factors of Decline Addressed
Bear Creek R 1	Understand flows and hydrologic regime in Bear Creek subarea, and identify ways to protect and maintain them. Identify critical ground and surface water withdrawal locations and volumes in the subarea, as well as their impact on salmon, in-stream habitat, and habitat-forming processes.	Altered hydrology and flow
Bear Creek R 2	Understand and reduce impact of elevated nutrients in Bear Creek.	Poor water quality (nutrients)
Bear Creek R 3	Continue ongoing juvenile salmon out-migration studies for Bear Creek.	Altered hydrology and flow Fish access and passage barriers Loss of channel complexity and connectivity Increased sedimentation and altered sediment transport processes

Map 10. Bear Creek Subarea

Issaquah Creek and Chinook-Bearing Tributaries

The Issaquah Creek subarea encompasses approximately 61 square miles of King County. The creek's headwaters flow from the steep slopes of Cougar, Squak, Tiger, and Taylor mountains into Lake Sammamish. (See Map 11, Issaquah Creek Subarea.) The subarea includes Issaquah Creek and its tributaries: Holder Creek, Carey Creek, Fifteenmile Creek, and McDonald Creek. It also includes the north and east forks of Issaquah Creek and Tibbets Creek. (Tibbets Creek is not actually a tributary to Issaquah Creek, but it shares a common floodplain with the mainstem during large flood events.) The Issaquah Creek subarea supports chinook, coho, and kokanee salmon and steelhead trout. It may also support bull trout. The middle and upper sections of Issaquah Creek have exceptional fish habitat; Carey Creek and Holder Creek, in particular, provide excellent habitat for salmon. The Issaquah Salmon Hatchery, which is managed by the Washington Department of Fish and Wildlife, currently produces chinook and coho salmon, as well as Lake Washington steelhead trout. All fish not needed for production are allowed to spawn in Issaquah Creek. In 2000, the hatchery began mass-marking all chinook and coho juveniles leaving the hatchery as a means of distinguishing returning hatchery adults from naturally produced fish.

The WRIA 8 Technical Committee identified the following factors of decline for the Issaquah Creek subarea: fish access and passage barriers; loss of channel complexity and connectivity; degradation of riparian condition; altered hydrology and flow; poor water quality (nutrients, chemical contamination, increased temperatures); and increased sedimentation and altered sediment transport processes.

The primary goals for Issaquah Creek are to:

- Protect and restore salmon habitat and habitat-forming processes in the Issaquah Creek subarea that contribute to the life cycle requirements of adult and juvenile salmon for spawning, rearing, and migration.
- Protect and maintain critical forest cover.

The following objectives will help achieve these goals:

- Allow unimpeded access to all potential natural spawning and rearing habitats for all life stages of salmon throughout the Issaquah Creek subarea.
- Protect the best remaining habitat and prevent degradation of existing high-quality habitat.
- Protect, enhance, and restore channel complexity, floodplain connectivity, and riparian conditions.
- Protect, maintain, and restore the flows and hydrologic regime.

- Eliminate impacts of increased nutrients and chemical contamination on salmon survival.
- Understand impacts of increased sedimentation and altered sediment transport processes in Issaquah Creek on salmon viability; identify opportunities to reduce impacts.
- Identify opportunities to protect and restore the temperature regime in Issaquah Creek.

Tables 4-25 through 4-27 present near-term recommendations for the Issaquah Creek subarea. The tables are organized by action alternatives, potential projects, and research. Action alternatives are general recommendations for actions that should be taken to address an identified factor of decline. Potential projects are more specific on-the-ground opportunities that have been identified for applying an action alternative, such as replanting riparian vegetation at a specific location in a subarea. Research activities are designed to help scientists gain a better understanding of a subarea's factors of decline and to learn what roles the factors play and how to address them.

Table 4-25. Issaquah Creek Action Alternatives

Action Alternative No./Action Alternative	Factors of Decline Addressed	Projects Identified
Issaquah Creek AA 1		
Provide access and passage at all physical, chemical, and biological blockages to fish migration. King County Road Maintenance is currently identifying and prioritizing fish passage barriers in the road right-of-way in unincorporated King County. This may generate additional fish passage improvement projects in the Issaquah Creek subarea.	Fish access and passage barriers	Issaquah Creek P 1
Issaquah Creek AA 2		
Identify and protect the best remaining habitat and prevent degradation of existing high-quality habitat.	Loss of channel complexity and connectivity Degradation of riparian condition Altered hydrology and flow Increased sedimentation and altered sediment transport processes Poor water quality	Issaquah Creek P 2
Issaquah Creek AA 3		
Retain forest cover in the Issaquah Creek subarea to the extent possible. The *Issaquah Creek Basin and Nonpoint Pollution Action Plan* (King County 1994) set goal of retaining a minimum of 65 percent forest cover to protect hydrologic regime. Identify opportunities to reduce effective impervious areas and convert grass areas to a forested landscape.	Altered hydrology and flow	Issaquah Creek P 3

Action Alternative No./Action Alternative	Factors of Decline Addressed	Projects Identified
Issaquah Creek AA 4		
Design and implement habitat restoration projects to increase channel complexity and connectivity. Identify opportunities to install large woody debris, especially in mainstem Issaquah Creek, Carey Creek, and Holder Creek where needed. Identify opportunities to reconnect potential or marginally functioning off-channel habitat or create new off-channel habitat and shallow mainstem habitat.	Loss of channel complexity and connectivity	Issaquah Creek P 4, 5
Issaquah Creek AA 5		
Identify opportunities to remove bank hardening and existing structures in the floodplain and/or soften hardened banks by using bioengineering techniques. Priority areas are Issaquah Creek mainstem, Carey Creek, and Holder Creek.	Loss of channel complexity and connectivity Degradation of riparian condition	Issaquah Creek P 6, 7
Issaquah Creek AA 6		
Identify opportunities for streambank bioengineering restoration projects in King County, City of Issaquah, and Tiger Mountain State Forest to help the hydrologic network return to a natural erosion-sediment transport rate.	Increased sedimentation and altered sediment transport processes	No projects identified at this time
Issaquah Creek AA 7		
Protect existing forested riparian buffers and identify opportunities to plant native coniferous trees in the riparian zones throughout the subarea. First priority should be the mainstems of Issaquah Creek, Carey Creek, and Holder Creek.	Degraded riparian conditions Loss of channel complexity and connectivity Poor water quality (increased temperature)	No projects identified at this time
Issaquah Creek AA 8		
Identify and retrofit old (pre-1998) stormwater retention/detention facilities to better retain, release, treat, and infiltrate stormwater.	Altered hydrology and flow Poor water quality (nutrients, chemical contamination)	Issaquah Creek P 8
Issaquah Creek AA 9		
Identify opportunities to reduce phosphorus, runoff, and fine sediments entering Issaquah Creek.	Poor water quality (nutrients, chemical contamination) Increased sedimentation and altered sediment transport processes Altered hydrology and flow	Issaquah Creek P 9

Potential projects for the Issaquah Creek subarea are listed in the following table and can be located on Map 11. Each project has been assigned a number (P 1, P 2, etc.), and for projects that include more than one task, a letter has been assigned to each task (a, b, c, etc.). On the

map, corresponding numbers and letters indicate the location of the project and task. For example, a map point marked 2a refers to project 2, task a. Not all projects are mapped, because some are not being conducted in a specific location. Projects that are not mapped are noted in the table.

Table 4-26. Issaquah Creek Potential Projects

Project Name	Type of Project
Issaquah Creek P 1 Issaquah Salmon Hatchery Fish Passage	**Fish Passage**
Work with Issaquah Salmon Hatchery to evaluate and amend its management protocol on passing species of salmon over the hatchery weir. Design and implement project to improve fish passage at Issaquah Salmon Hatchery Intake Dam.	
Issaquah Creek P 2 Habitat Protection	**Protection**
2a Mainstem Issaquah Creek RM 8.4-10 (155 acres)	
2b Holder Creek (inholding on Taylor and Tiger mountains)	
2c Carey Creek RM 0-Highway 18	
2d Carey Creek Highway 18 to Issaquah-Hobart Road	
2e Issaquah Mainstem (SE 156th Street to 252nd Avenue SE)	
2f Holder Creek (confluence with Carey Creek to Highway 18)	
2g Issaquah Mainstem (252nd Avenue SE to Carey/Holder confluence)	
2h Mainstem Issaquah Creek/Log Cabin Reach (RM 8.4-10, 155 acres).	
Continue and fund Issaquah Creek Waterways Program to identify and protect floodplain habitat along Issaquah Creek, Carey Creek, and Holder Creek. Protection of riparian habitat helps to preserve channel migration zones and allow for recruitment of large woody debris and gravel, and other habitat-forming processes.	
Issaquah Creek P 3 Forest Cover Protection	**Protection**
3a Protect existing natural flow regime in the headwaters areas of Carey and Holder creeks, which are in the Tiger Mountain State Forest and Taylor Mountain County Forest vicinity, by acquiring forest property, development rights/conservation easements. Also, provide enhanced incentives to retain and plant forest area environments. (Supported by the WRIA 8 Flow Subcommittee's report on changes in hydrology in WRIA 8 that highlighted Upper Issaquah Creek as having minimal impact from land cover change, water withdrawal, and sewers. The report is included in the *Salmon and Steelhead Habitat Limiting Factors Report for Cedar-Sammamish Basin* in the chapter that discusses change in hydrologic regime.)	
3b Acquire additional forested areas along Fifteenmile Creek, East Fork, and McDonald Creek.	
Issaquah Creek P 4 Squak Valley Restoration Project	**Restoration**
The U.S. Army Corps of Engineers and the City of Issaquah are designing off-channel habitat for salmon rearing and refuge along Issaquah Creek approximately 4 1/2 miles upstream of Lake Sammamish. Site is approximately 7 acres; design consists of removing portions of an existing levee to allow winter flow through a meandered channel, providing large woody debris, and planting riparian vegetation. Construction is scheduled to start in spring of 2002.	
Issaquah Creek P 5 Addition of Large Woody Debris to Issaquah Creek	**Restoration**
Consider adding large woody debris to Issaquah Creek between RM 8.4 and RM 10.	

Project Name	Type of Project
Issaquah Creek P 6 Potential Sites for Removal of Bank Hardening	**Streambank Restoration**
6a Confluence of Issaquah Creek and Fifteenmile Creek	
6b Issaquah Creek at RM 7.5	
6c Hang Glider Creek at RM 0.3	
6d Issaquah Creek between RM 7.4 and RM 7.7	
6e Four Creek subdivision	
6f Issaquah Creek confluence with McDonald Creek.	
Issaquah Creek P 7 City of Issaquah Floodway Restoration Program (not mapped)	**Restoration**
Continue City of Issaquah's floodway restoration program, which improves chinook habitat on Issaquah Creek within the city by bioengineering streambanks to meet multiple objectives, including fish habitat.	
Issaquah Creek P 8 I-90 Stormwater Improvements (not mapped)	**Improved Stormwater Facilities**
I-90 has few water-quality treatment facilities or water retention/detention facilities for the hundreds of acres of impervious surfaces that flow directly into the East Fork, North Fork, and mainstem of Issaquah Creek. Work with Washington Department of Ecology and Washington State Department of Transportation to provide improvements and spill containment system.	
Issaquah Creek P 9 Implementation of Lake Sammamish Water Quality Plan (not mapped)	**Water Quality Plan**
Implement the *Lake Sammamish Water Quality Management Plan* (Entranco December 1996). This plan focuses on reducing phosphorus inputs to Lake Sammamish. The Issaquah Creek subarea is a potential major source because it provides 70 percent of the volume of surface water input to Lake Sammamish.	

Table 4-27. Issaquah Creek Research

Research No.	Research Description	Factors of Decline Addressed
Issaquah Creek R 1	Understand flows and hydrologic regime in Issaquah Creek subarea. Identify critical groundwater and surface water withdrawal locations and volumes in the subarea, their impact on salmon, in-stream habitat, and habitat-forming processes. Identify ways to protect and maintain existing flow regime and restore a more natural flow regime.	Altered hydrology and flow
Issaquah Creek R 2	In particular, analyze hydrology and flows in North Fork Issaquah Creek, East Fork Issaquah Creek, and the lower mainstem of Issaquah Creek that were identified by the WRIA 8 Flow Subcommittee as having low flow problems. (See *Salmon and Steelhead Habitat Limiting Factors Report for Cedar-Sammamish Basin,* Change in Hydrologic Regime, p. 450) Evaluate necessity of corrective water management actions.	Altered hydrology and flow

Map 11. Issaquah Creek Subarea

Little Bear Creek

Little Bear Creek, which encompasses a drainage area of approximately 15 square miles, begins in Snohomish County, flows southward into King County, and empties into the Sammamish River. (See Map 12, Little Bear Creek Subarea.) Approximately 80 percent of the Little Bear Creek subarea is located within Snohomish County. Anadromous salmon and trout access almost all of this system, though there are some significant passage barriers to adults at low-flow periods and to juveniles during high flows. Little Bear Creek is currently the least developed of the three main north tributaries to the Sammamish River, and it has the least degraded habitat. Little Bear Creek supports runs of chinook, sockeye, kokanee, and coho salmon.

The WRIA 8 Technical Committee identified the following factors of decline for the Little Bear Creek subarea: fish access and passage barriers; loss of channel complexity and connectivity; altered hydrology and flow; increased sedimentation and altered sediment transport processes; degradation of riparian condition; poor water quality (increased temperature, poor water quality, and other conditions).

The primary goal for the Little Bear Creek subarea is to protect and restore salmon habitat and habitat-forming processes in Little Bear Creek that contribute to the life cycle requirements of adult and juvenile salmon for spawning, rearing, and migration.

The following objectives will help achieve this goal:

- Provide unimpeded access to all potential natural spawning and rearing habitats for all life stages of salmon.
- Protect and restore channel complexity and floodplain connectivity.
- Protect and maintain a more natural hydrologic regime in Little Bear Creek and its tributaries.
- Reduce runoff and fine sediments entering Little Bear Creek.
- Reduce accelerated streambank erosion.
- Maintain and restore a more natural thermal regime in Little Bear Creek.
- Protect and restore riparian conditions.
- Reduce nutrient loading and the impact of elevated nutrients on salmon viability.

Tables 4-28 through 4-30 present near-term recommendations for the Little Bear Creek satellite subarea. The tables are organized by action alternatives, potential projects, and research. Action alternatives are general recommendations for actions that should be taken to address an identified factor of decline. Potential projects are more specific on-the-ground opportunities that have been identified for applying an action alternative, such as replanting riparian vegetation at a specific

location in a subarea. Research activities are designed to help scientists gain a better understanding of a subarea's factors of decline and to learn what roles the factors play and how to address them.

Table 4-28. Little Bear Creek Action Alternatives

Action Alternative No./Action Alternative	Factors of Decline Addressed	Projects Identified
Little Bear Creek AA 1		
Restore fish access at identified fish passage barriers (as identified by Snohomish County, Washington Department of Fish and Wildlife, or Adopt-A-Stream Foundation and other assessments based on Washington Department of Fish and Wildlife standard fish passage barrier protocols and prioritization).	Fish access and passage barriers	Little Bear Creek P 1, 2
Little Bear Creek AA 2		
Preserve and restore upland forest cover throughout Little Bear Creek subarea. Identify opportunities to reduce levels of subarea-wide percent effective impervious area and increase pervious land cover by converting grass and shrub/scrub land cover to native forest.	Altered hydrology and flow	Little Bear Creek P 3
Little Bear Creek AA 3		
Protect best remaining riparian habitat and high-quality intact riparian forest cover.	Lack of channel complexity and connectivity Degraded riparian condition Altered hydrology and flow	Little Bear Creek P 4, 5, 6, 7
Little Bear Creek AA 4		
Identify opportunities to restore riparian conditions. Plant native coniferous trees in the riparian zones throughout the subarea, especially in tributary and headwater streams and south of Maltby Road. Reduce invasive non-native plants (particularly reed canarygrass and Japanese knotweed) in chinook-bearing stream segments by recovering natural riparian communities, especially south of Maltby Road. Vigorously protect riparian habitats north of Maltby Road to prevent further dispersal of non-native vegetation.	Lack of channel complexity and connectivity Degraded riparian condition	No projects identified at this time
Little Bear Creek AA 5		
Identify opportunities to buy out frequently flood-damaged homes or property and restore floodplain and riparian conditions.	Lack of channel complexity and connectivity Degraded riparian condition	No projects identified at this time

Action Alternative No./Action Alternative	Factors of Decline Addressed	Projects Identified
Little Bear Creek AA 6		
Identify opportunities to increase channel complexity and floodplain connectivity. Identify opportunities to reconnect off-channel rearing and refuge habitats, especially those that may exist in proximity to tributary confluences and that currently are partially or totally isolated by floodplain modifications.	Lack of channel complexity and connectivity Degraded riparian condition	Little Bear Creek P 8
Little Bear Creek AA 7		
Identify and preserve headwater, tributary, and floodplain wetlands in the Little Bear Creek subarea.	Altered hydrology and flow	No projects identified at this time
Little Bear Creek AA 8		
Identify opportunities to retrofit stormwater retention/detention facilities and outfall locations to current standards to better retain, release, treat, and infiltrate storm water. Apply measures to control stormwater heating, consistent with revised adopted standards (for example, Washington Department of Ecology, *King County Surface Water Design Manual* [King County September 1998]).	Altered hydrology and flow Poor water quality (temperature, other)	Little Bear Creek P 9
Little Bear Creek AA 9		
Identify opportunities to address increased sedimentation and altered sediment transport processes in Little Bear Creek by: ▪ Reducing construction runoff and fine sediments ▪ Reducing erosion and sedimentation from livestock or trail access to streams ▪ Reducing accelerated streambank erosion, especially south of Maltby Road.	Increased sedimentation and altered sediment transport processes	Little Bear Creek P 10
Little Bear Creek AA 10		
Identify opportunities to reduce nutrient loading and the impact of elevated nutrients in Little Bear Creek.	Poor water quality (other)	No projects identified at this time

Potential projects for the Little Bear Creek subarea are listed in the following table and can be located on Map 12. Each project has been assigned a number (P 1, P 2, etc.), and for projects that include more than one task, a letter has been assigned to each task (a, b, c, etc.). On the map, corresponding numbers and letters indicate the location of the project and task. For example, a map point marked 2a refers to project 2, task a. Not all projects are mapped, because some are not being conducted in a specific location. Projects that are not mapped are noted in the table.

Table 4-29. Little Bear Creek Potential Projects

Project Name	Type of Project
Little Bear Creek P 1 Fish Passage Project Benefiting All Species (Including Chinook)	**Fish Passage**
The following projects are based on Adopt-A-Stream Foundation 1999 Level A analysis and repair required or fishway conversion recommendations per Washington Department of Fish and Wildlife inventory and assessment protocols:	
Mainstem of Little Bear Creek:	
1a 132nd Avenue NE, RM .45, City of Woodinville	
1b 134th Avenue NE (three cement pipes, broken), RM 0.5, City of Woodinville	
1c NE 195th Street, degraded vortex weir, RM 1.8, City of Woodinville	
1d NE 205th Street, RM 1.9, City of Woodinville	
1e 51st Avenue NE, RM 6.5, Snohomish County Public Works	
1f 180th Street SE, RM 7.2, Snohomish County Public Works	
Great Dane Creek:	
1g Private drive at SR 524 (Maltby Road), RM 0.28, Private	
1h SR 524 (Maltby Road), RM 0.28, Washington State Department of Transportation.	
Little Bear Creek P 2 Fish Passage Projects Benefiting Other Species	**Fish Passage**
Other projects principally benefiting coho salmon and steelhead and cutthroat trout. The following projects are based on Adopt-A-Stream Foundation 1999 Level A analysis and repair required or fishway conversion recommendations per Washington Department of Fish and Wildlife inventory and assessment protocols:	
Great Dane Creek:	
2a Private drive at SR 9, RM 0.69, BPA right-of-way (two culverts)	
Cutthroat Creek:	
2b Private drive at Highway 9, RM 0.01	
2c SR 9, RM 0.18, Washington State Department of Transportation	
2d Private drive, Marwood Place, RM 0.86	
2e Private drive, at 78th Avenue SE, RM 1.1	
Trout stream:	
2f 65th Avenue SE, RM 1.17, private	
2g 65th Avenue SE, RM 1.21, Snohomish County Public Works.	
Little Bear Creek P 3 Forest Cover Protection	**Protection**
3a Little Bear Creek Headwater Forest: Site 1 (88 acres of mature second-growth forest on right bank of Little Bear Creek)	
3b Merwin property and adjacent forested parcels (23 acres of hydrologically mature forest cover and wetland area)	
3c Maltby Road property, five parcels totaling 35 acres of mature second-growth upland forest, without critical areas protection	
3d Cutthroat Creek corridor property, 3,000 feet of creek frontage and riparian forest, identified in *Little Bear Creek Reconnaissance Report* (Snohomish County 1993) (not mapped)	
3e Trout Stream corridor property (57th Avenue SE to 65th Avenue SE), identified in *Little Bear Creek Reconnaissance Report*	
3f Acquisition of additional upland forested areas as identified in Snohomish County's Endangered Species Act Priority Land Acquisition Program (not mapped)	
3g Funding of Snohomish County's Urban Growth Area Greenspaces program to include non-urban growth areas in Little Bear Creek in order to identify potential riparian and upland acquisition sites (not mapped)	

Project Name	Type of Project
3h Acquisition of several acres of forest cover in the City of Woodinville adjacent to Woodinville High School (not mapped)	
3i Acquisition of additional upland forested areas as identified in the *Little Bear Creek Corridor Habitat Assessment* (David Evans and Associates 2002). (not mapped)	
Little Bear Creek P 4 Streamside Properties Protection (not mapped)	**Protection**
Identify potential streamside properties to acquire that would qualify for development through the variance process because of their size or configuration, within otherwise protected stream or riparian wetland buffer areas. Query Tri-County database of vacant and development-constrained parcels to identify potential acquisitions.	
Little Bear Creek P 5 Intact Riparian Forest Protection (not mapped)	**Protection**
Acquire up to 300-foot conservation easements on riparian corridors in chinook-bearing and non-chinook salmon-bearing streams and stream segments that otherwise would not receive the highest levels of regulatory protection. Non-chinook salmon-bearing streams to be protected would include Trout Stream, Cutthroat Creek, Great Dane Creek, Little Bear Creek north of 51st Avenue SE (south crossing), Rowlands Creek, and other minor tributaries that act to regulate the thermal regime of Little Bear Creek.	
Little Bear Creek P 6 Riparian Easements South of Maltby Road (not mapped)	**Protection**
Acquire conservation easements in order to conduct riparian habitat restoration (in conjunction with floodplain restoration projects), especially south of Maltby Road.	
Little Bear Creek P 7 Snohomish County Greenspaces Program (not mapped)	**Protection**
Fund Snohomish County's Urban Growth Area Greenspaces program to include Little Bear Creek in order to foster community-based open space protection. Coordinate with City of Woodinville and King County.	
Little Bear Creek P 8 Places to Increase Channel Complexity and Floodplain Connectivity	**Restoration**
8a Enhance large woody debris recruitment and frequency between 180th Street SE and Maltby Road – a stream segment dominated by mixed forest riparian conditions and high canopy cover but lacking an instream abundance of large woody debris.	
8b Reduce streambank scouring and restore floodplain connectivity, especially south of Maltby Road where streambank armoring and riparian encroachment are more prevalent. Reference local assessment efforts to identify potential priorities. (not mapped)	
Little Bear Creek P 9 Stormwater Improvements at 156th Street SE	**Stormwater Improvement**
Mitigate heated stormwater effluent at 156th Street SE.	
Little Bear Creek P 10 Implementation of Livestock Best Management Practices (not mapped)	**Restoration**
Work with subarea farm owners to ensure that livestock access and water crossing areas are restabilized and limited, and that streambanks are bioengineered and replanted to recover riparian functions.	

Table 4-30. Little Bear Creek Research

Research No.	Research Description	Factors of Decline Addressed
Little Bear Creek R 1	Conduct additional Washington Department of Fish and Wildlife–based Level B analysis on unknown barriers as identified by Level A analysis; develop priority index values for individual passage barriers based on upstream habitat availability and quality.	Fish access and passage barriers
Little Bear Creek R 2	Conduct drainage inventory to identify poorly constructed stormwater outfall areas that contribute to drainage problems, streambank erosion, fine sediment accumulation, and water-quality problems. Identify opportunities and needs for regional detention.	Altered hydrology/flow Poor water quality (temperature, other)
Little Bear Creek R 3	Investigate observed variability in temperature throughout the Little Bear Creek subarea and identify contributing factors (natural or anthropogenic) to higher water temperature by screening surface water outfalls. Identify cold-water resources from groundwater.	Poor water quality (temperature)

Map 12. Little Bear Creek Subarea

North Creek

North Creek begins in the City of Everett, in Snohomish County, and flows southward into King County, where it empties into the Sammamish River. (See Map 13, North Creek Subarea.) The subarea contains approximately 117 miles of stream; major lakes include Silver Lake, Ruggs Lake, and Thomas Lake. Approximately 49 percent of the subarea, including the lakes, is covered by impervious surface (paved surfaces, buildings, etc.); more than 98 percent lies within the urban growth boundary. North Creek supports runs of chinook, sockeye, kokanee, and coho salmon and steelhead trout.

The WRIA 8 Technical Committee identified the following factors of decline for the North Creek subarea: fish access and passage barriers; loss of channel complexity and connectivity; altered hydrology and flow; increased sedimentation and altered sediment transport processes; degradation of riparian condition; and poor water quality (increased temperature, other).

The primary goal for the North Creek subarea is to protect and restore salmon habitat and habitat-forming processes in North Creek that contribute to the life cycle requirements of adult and juvenile salmon for spawning, rearing, and migration.

The following objectives will help achieve this goal:

- Provide unimpeded access to all potential natural spawning and rearing habitats for all life stages of salmon.
- Protect and restore channel complexity and floodplain connectivity.
- Protect and restore a more natural hydrologic regime.
- Reduce runoff and fine sediments.
- Reduce accelerated streambank erosion, especially south of SE 164th Street.
- Maintain and restore a more natural temperature regime.
- Protect and restore riparian habitats.
- Reduce nutrient and chemical pollutant loading and the resulting impacts on salmon.

Tables 4-31 through 4-33 present near-term recommendations for the North Creek satellite subarea. The tables are organized by action alternatives, potential projects, and research. Action alternatives are general recommendations for actions that should be taken to address an identified factor of decline. Potential projects are more specific on-the-ground opportunities that have been identified for applying an action alternative, such as replanting riparian vegetation at a specific location in a subarea. Research activities are designed to help scientists gain a better understanding of a subarea's factors of decline and to learn what roles the factors play and how to address them.

Table 4-31. North Creek Action Alternatives

Action Alternative No./Action Alternative	Factors of Decline Addressed	Projects Identified
North Creek AA 1		
Restore fish access at identified fish passage barriers (as identified by Snohomish County, Washington Department of Fish and Wildlife, or Adopt-A-Stream Foundation and other assessments based on Washington Department of Fish and Wildlife standard fish passage barrier protocols and prioritization).	Fish access and passage barriers	North Creek P 1, 2
North Creek AA 2		
Preserve and restore upland forest cover. Identify opportunities to reduce levels of subarea-wide percent effective impervious area and increase pervious land cover by converting grass and shrub/scrub land cover to native forest.	Altered hydrology/flow	North Creek P 3
North Creek AA 3		
Protect best remaining riparian habitat and high-quality intact riparian forest cover.	Lack of channel complexity/ connectivity Degraded riparian condition Altered hydrology/flow	North Creek P 4, 5, 6, 7, 8
North Creek AA 4		
Identify opportunities to restore riparian conditions. Plant native coniferous trees in the riparian zones throughout the subarea, especially in tributary and headwater streams and south of SE 164th Street. Reduce invasive non-native plants (particularly reed canarygrass and Japanese knotweed) in chinook-bearing stream segments by recovering natural riparian communities, especially south of SE 164th Street. Protect riparian habitats north of SE 164th Street and south of SE 128th Street to prevent further dispersal of non-native vegetation.	Lack of channel complexity/connectivity Degraded riparian condition	North Creek P 8
North Creek AA 5		
Identify opportunities to buy out frequently flood-damaged homes or property and restore floodplain and riparian conditions.	Lack of channel complexity/ connectivity Degraded riparian condition	No projects identified at this time
North Creek AA 6		
Identify opportunities to increase channel complexity and floodplain connectivity. Identify opportunities to reconnect off-channel rearing and refuge habitats, especially those that may exist in proximity to tributary confluences and that are partially or totally isolated by floodplain modifications at this time.	Lack of channel complexity/ connectivity Degraded riparian condition	North Creek P 9
North Creek AA 7		
Preserve headwater, tributary, and floodplain wetlands in the North Creek subarea.	Altered hydrology/flow	No projects identified at this time

Action Alternative No./Action Alternative	Factors of Decline Addressed	Projects Identified
North Creek AA 8		
Identify opportunities to retrofit stormwater retention/detention facilities and outfall locations to current standards to better retain, release, treat, and infiltrate stormwater. Apply measures to control stormwater heating, consistent with revised adopted standards (for example, Washington Department of Ecology, *King County Surface Water Design Manual*). Specifically, investigate opportunities to control stormwater heating in lower Silver Creek and Tambark Creek.	Altered hydrology/flow Poor water quality (temperature, other)	No projects identified at this time
North Creek AA 9		
Identify opportunities to address increased sedimentation and altered sediment transport processes in North Creek by: ▪ Reducing construction runoff and fine sediments ▪ Reducing erosion and sedimentation from livestock or trail access to streams ▪ Reducing accelerated streambank erosion, especially south of SE 164th Street.	Increased sedimentation and altered sediment transport processes	No projects identified at this time
North Creek AA 10		
Identify opportunities to reduce nutrient loadings and chemical pollutants in North Creek and reduce impact of elevated nutrients and chemical pollutants.	Poor water quality (other)	North Creek P 10

Potential projects for the North Creek subarea are listed in the following table and can be located on Map 13. Each project has been assigned a number (P 1, P 2, etc.), and for projects that include more than one task, a letter has been assigned to each task (a, b, c, etc.). On the map, corresponding numbers and letters indicate the location of the project and task. For example, a map point marked 2a refers to project 2, task a. Not all projects are mapped, because some are not being conducted in a specific location. Projects that are not mapped are noted in the table.

Table 4-32. North Creek Potential Projects

Project Name	Type of Project
North Creek P 1 Fish Passage Project Benefiting All Species (Including Chinook)	**Fish Passage**
The following projects are based on Adopt-A-Stream Foundation 1999-2001 Level A analysis and repair required or fishway conversion recommendations per Washington Department of Fish and Wildlife inventory and assessment protocols: Penny Creek: 1a Ninth Avenue, RM 0.05, City of Mill Creek 1b Two culverts along Mill Creek Community Trail, RM 1.00, are degrading and represent fish passage barriers due to slope conditions or imminent failure. Tambark Creek: 1c Two culverts on 22nd Avenue SE, RM 0.17, private. Both culverts are undersized and act as partial barriers. 1d 35th Avenue SE, RM 1.3, Snohomish County. The culvert is undersized, and the bed material fills with sand.	

Project Name	Type of Project
North Creek P 2 Fish Passage Projects Benefiting Other Species (not mapped)	**Fish Passage**
Implement other fish passage projects as identified (by Snohomish County Surface Water Management Drainage Needs program).	
North Creek P 3 Upland Forest Cover Protection	**Protection**
3a Acquire North Creek Hillslope Forest Site (53 acres of mature second-growth forest/wetlands on right bank of North Creek).	
3b Acquire additional high-quality riparian/wetland and upland forested areas as identified in Snohomish County's Endangered Species Act Priority Land Acquisition Program, particularly between SE 164th Street and SR 524. Acquisition of open space would fulfill a key component of the *North Creek Comprehensive Flood Hazard Management Plan* (CH2M Hill 1997).	
3c Implement habitat enhancement projects identified by Snohomish County Surface Water Management Drainage Needs program. (not mapped)	
North Creek P 4 Streamside Properties Protection (not mapped)	**Protection**
Identify potential streamside properties to acquire that would allow development through the variance process because of their size or configuration, within otherwise protected stream or riparian wetland buffer areas. Acquire streamside properties, especially those that are contiguous to high-quality forested or wetland upland habitats. Focus particularly on habitats between SR 524 and SE 128th Street, including tributary streams. Query Tri-County database of vacant and development constrained parcels to identify potential acquisitions.	
North Creek P 5 Intact Riparian Forest Protection (not mapped)	**Protection**
Acquire up to 300-foot conservation easements on riparian corridors in chinook-bearing streams and non-chinook salmon-bearing streams and stream segments that otherwise would not receive the highest levels of regulatory protection. The non-chinook salmon-bearing streams to be protected would include Tambark Creek, Penny Creek, Mill Creek (Smokehouse Creek), Nickel Creek, Filbert Creek, and Sulfur Spring Creek, as well as minor tributaries.	
North Creek P 6 Snohomish County Greenspaces Program (not mapped)	**Protection**
Fund implementation of Snohomish County's Urban Growth Area Greenspaces program to acquire high-quality riparian habitats and open space protection.	
North Creek P 7 Snohomish County Endangered Species Act Priority Land Acquisition (not mapped)	**Protection**
Acquire other high-quality riparian habitats identified under Snohomish County's Endangered Species Act Priority Land Acquisition Program and Snohomish County Surface Water Management Drainage Needs program.	
North Creek P 8 Acquisition of Conservation Easements for Future Restoration Projects (not mapped)	**Protection/ Restoration**
Acquire conservation easements in order to conduct riparian habitat restoration (in conjunction with floodplain restoration projects) especially south of SE 164th Street (contiguous to already publicly owned lands) and south of SR 524, as well as in Silver Creek, Tambark Creek, Penny Creek, Mill Creek, Filbert Creek, and other tributaries.	
North Creek P 9 Opportunities to Increase Channel Complexity and Connectivity	**Restoration**
9a Enhance large woody debris recruitment and frequency between 164th Street SE and SR 524 on North Creek—a stream segment dominated by shrub/scrub and mixed forest riparian conditions, and notably lacking an instream abundance of large woody debris.	
9b Reduce streambank scouring and restore floodplain connectivity, especially south of SE 164th Street to SR 527 on North Creek, which historically was channelized and where riparian encroachment is more prevalent.	
North Creek P 10 Water Quality Plan (not mapped)	**Plan Implementation**
10a Implement projects specified in the *North Creek Watershed Management Plan* (Snohomish County Works Surface Water Management 1994).	
10b Implement North Creek total maximum daily load and support priority implementation actions.	

Table 4-33. North Creek Research

Research No.	Research Description	Factors of Decline Addressed
North Creek R 1	Conduct additional Washington Department of Fish and Wildlife–based Level B analysis on unknown barriers as identified by Level A analysis; develop priority index values for individual passage barriers based on upstream habitat availability and quality.	Fish access and passage barriers
North Creek R 2	Conduct drainage inventory to identify poorly constructed stormwater outfall areas that contribute to drainage problems, streambank erosion, fine sediment accumulation, and water-quality problems. Identify opportunities and needs for regional detention.	Altered hydrology/flow Poor water quality (temperature, other)
North Creek R 3	Investigate observed variability in temperature throughout the North Creek subarea and identify contributing factors (natural or anthropogenic) to higher water temperature. Identify cold-water resources from groundwater.	Poor water quality (temperature)

Map 13. North Creek Subarea

Swamp Creek

Swamp Creek begins in Snohomish County and flows southward into King County, where it empties into the Sammamish River. (See Map 14, Swamp Creek Subarea.) This subarea contains Scriber Lake, Martha Lake, Lake Stickney, and 98 miles of stream channels. It drains portions of Lynnwood, Everett, Brier, Bothell, Mountlake Terrace, Kenmore, and unincorporated Snohomish County. It is estimated that 52 percent of the subarea is impervious surface (paved surfaces, buildings, etc.). All of the subarea is located within the urban growth areas of Snohomish and King counties and incorporated areas. Swamp Creek supports runs of chinook, sockeye, kokanee, and coho salmon and steelhead trout.

The WRIA 8 Technical Committee identified the following factors of decline for the Swamp Creek subarea: fish access and passage barriers; loss of channel complexity and connectivity; altered hydrology and flow; increased sedimentation and altered sediment transport processes; degradation of riparian condition**;** and poor water quality (increased temperature, other).

The primary goal for the Swamp Creek subarea is to protect and restore salmon habitat and habitat-forming processes in Swamp Creek that contribute to the life cycle requirements of adult and juvenile salmon for spawning, rearing, and migration.

The following objectives will help achieve this goal:

- Provide unimpeded access to all potential natural spawning and rearing habitats for all life stages of salmon.
- Protect and restore channel complexity and floodplain connectivity.
- Protect and restore a more natural hydrologic regime.
- Protect and restore riparian habitats.
- Reduce runoff and fine sediments.
- Reduce accelerated streambank erosion, especially south of confluence with Scriber Creek.
- Maintain and restore a more natural temperature regime.
- Restore normal dissolved oxygen levels particularly in lower Swamp Creek.
- Reduce nutrient and chemical pollutant loading and their impacts on salmon.

Tables 4-34 through 4-36 present near-term recommendations for the Swamp Creek satellite subarea. The tables are organized by action alternatives, potential projects, and research. Action alternatives are general recommendations for actions that should be taken to address an identified factor of decline. Potential projects are more specific on-the-ground opportunities that have been identified for applying an action alternative, such as replanting riparian vegetation at a specific location in a subarea. Research activities are designed to help scientists gain a better understanding of a subarea's factors of decline and to learn what roles the factors play and how to address them.

Table 4-34. Swamp Creek Action Alternatives

Action Alternative No./Action Alternative	Factors of Decline Addressed	Projects Identified
Swamp Creek AA 1		
Restore fish access at identified fish passage barriers (as identified by Snohomish County, Washington Department of Fish and Wildlife, or Adopt-A-Stream Foundation and other assessments based on Washington Department of Fish and Wildlife standard fish passage barrier protocols and prioritization).	Fish access and passage barriers	Swamp Creek P 1, 2
Swamp Creek AA 2		
Preserve and restore upland forest cover. Protect flood attenuation functions also provided by numerous lakes and associated wetlands. Identify opportunities to reduce levels of subarea-wide percent effective impervious area and increase pervious land cover by converting grass and shrub/scrub land cover to native forest.	Altered hydrology and flow	Swamp Creek P 3
Swamp Creek AA 3		
Protect best remaining riparian habitat and high-quality intact riparian forest cover.	Lack of channel complexity and connectivity Degraded riparian condition Altered hydrology and flow	Swamp Creek P 4
Swamp Creek AA 4		
Identify opportunities to restore riparian conditions. Plant native coniferous trees in the riparian zones throughout the subarea, especially in tributary and headwater streams and south of SR 524. Reduce invasive non-native plants (particularly reed canarygrass and Japanese knotweed) in chinook-bearing stream segments by recovering natural riparian communities, especially south of SR 524.	Lack of channel complexity and connectivity Degraded riparian condition	Swamp Creek P 5, 6
Swamp Creek AA 5		
Identify opportunities to buy out frequently flood-damaged homes or property and restore floodplain and riparian conditions.	Lack of channel complexity and connectivity Degraded riparian condition	No projects identified at this time

Action Alternative No./Action Alternative	Factors of Decline Addressed	Projects Identified
Swamp Creek AA 6		
Identify opportunities to increase channel complexity and floodplain connectivity. Identify opportunities to reconnect off-channel rearing and refuge habitats, especially those that may exist in proximity to tributary confluences (for example, Locust Creek) and that currently are partially or totally isolated by floodplain modifications.	Lack of channel complexity and connectivity Degraded riparian condition Poor water quality (increased temperature)	Swamp Creek P 7, 8
Swamp Creek AA 7		
Preserve headwater, tributary, and floodplain wetlands in the Swamp Creek subarea.	Altered hydrology and flow	Swamp Creek P 9
Swamp Creek AA 8		
Identify opportunities to retrofit stormwater retention/detention facilities and outfall locations to current standards to better retain, release, treat, and infiltrate stormwater. Apply measures to control stormwater heating, consistent with revised adopted standards (for example, Washington Department of Ecology, *King County Surface Water Design Manual*). In particular, investigate opportunities to control stormwater heating in upper Swamp Creek.	Altered hydrology and flow Poor water quality (temperature, other)	No projects identified at this time
Swamp Creek AA 9		
Identify opportunities to address increased sedimentation and altered sediment transport processes in Swamp Creek by: ▪ Reducing construction runoff and fine sediments ▪ Reducing erosion and sedimentation from livestock and trail access to streams ▪ Reducing accelerated streambank erosion, especially south of confluence with Scriber Creek.	Increased sedimentation and altered sediment transport processes	No projects identified at this time
Swamp Creek AA 10		
Identify opportunities to restore dissolved oxygen levels; reduce nutrient loadings and chemical pollutants in Swamp Creek; and reduce impact of low dissolved oxygen, elevated nutrients, and chemical pollutants.	Poor water quality (other)	Swamp Creek P 10

Potential projects for the Swamp Creek subarea are listed in the following table and can be located on Map 14. Each project has been assigned a number (P 1, P 2, etc.), and for projects that include more than one task, a letter has been assigned to each task (a, b, c, etc.). On the map, corresponding numbers and letters indicate the location of the project and task. For example, a map point marked 2a refers to project 2, task a. Not all projects are mapped, because some are not being conducted in a specific location. Projects that are not mapped are noted in the table.

Table 4-35. Swamp Creek Potential Projects

Project Name	Type of Project
Swamp Creek P 1 Fish Passage Project Benefiting All Species (Including Chinook)	**Fish Passage**
1a Repair and/or retrofit culverts under I-405 and I-5 on Swamp Creek. Conduct additional assessment as needed.	
1b Inventory and assess fish passage barriers on Locust Creek.	
1c Repair or replace culvert on Golde Creek, RM 0.75, private. (not mapped)	
1d Replace culvert on Little Swamp Creek, King County, RM 0.27, NE 192nd Street, Kenmore Public Works.	
Swamp Creek P 2 Fish Passage Projects Benefiting Other Species (not mapped)	**Fish Passage**
Implement other fish passage projects identified by Snohomish County Surface Water Management Drainage Needs program.	
Swamp Creek P 3 Upland Forest Cover Protection	**Protection**
3a Acquire Lake Stickney shoreline wetlands and upland habitats.	
3b Acquire Locust Way property south of 234th Pl. SW.	
3c Acquire numerous wetlands in Scriber Creek north of Larch Way and east of 44th Avenue W.	
3d Acquire additional high-quality riparian and upland forested areas as identified in Snohomish County's Endangered Species Act Priority Land Acquisition Program. (not mapped)	
Swamp Creek P 4 Streamside Properties Protection (not mapped)	**Protection**
4a Identify potential streamside properties to acquire, especially those within the floodplain, which because of their size or configuration, would allow development through the variance process within otherwise protected stream or riparian wetland buffer areas. Acquire streamside properties especially that are contiguous to high-quality forested or wetland upland habitats. Focus particularly on habitats south of SR 524 and south of 44th Avenue W on Scriber Creek. Query Tri-County database of vacant and development constrained parcels to identify potential acquisitions.	
4b Acquire up to 300-foot conservation easements on riparian corridors in chinook-bearing and non-chinook salmon-bearing streams and stream segments that otherwise would not receive the highest levels of regulatory protection.	
4c Fund implementation of Snohomish County's Urban Growth Area Greenspaces program to acquire high-quality riparian habitats and open space protection.	
4d Acquire other high-quality riparian habitats identified under Snohomish County's Endangered Species Act Priority Land Acquisition Program.	
Swamp Creek P 5 Implementation of Surface Water Management Drainage Needs Program (not mapped)	**Protection/ Restoration**
Implement habitat enhancement projects identified by Snohomish County Surface Water Management Drainage Needs program.	
Swamp Creek P 6 Acquisition of Conservation Easements for Future Restoration Projects (not mapped)	**Protection**
Acquire conservation easements in order to conduct riparian habitat restoration (in conjunction with floodplain restoration projects), especially south of SR 524 and south of the confluence with Locust Creek.	

Project Name	Type of Project
Swamp Creek P 7 Opportunities to Increase Channel Complexity and Connectivity	**Restoration**
7a Enhance large woody debris recruitment and frequency between SR 524 and the confluence with Scriber Creek—a stream segment dominated by shrub/scrub and mixed forest riparian conditions and notably lacking an instream abundance of large woody debris.	
7b Reduce streambank scouring and restore floodplain connectivity, especially south of the confluence with Scriber Creek, where riparian encroachment and streambank armoring are more prevalent. Acquire Locust Way property south of 234th Place SW. (not mapped)	
Swamp Creek P 8 Wallace Swamp Creek Park Sediment Pond Removal	**Restoration**
Remove or modify sediment pond at Wallace Swamp Creek Park and restore channel complexity in stream reach. Project should also help to address elevated water temperatures in stream reach. Upstream sources of sedimentation will have to be studied and addressed.	
Swamp Creek P 9 Scriber Creek Wetlands (not mapped)	**Protection**
Acquire largest wetland areas remaining in Scriber Creek basin (to protect flood attenuation functions) that are not currently protected by ordinance, held in public ownerships, or in a protective tract status.	
Swamp Creek P 10 Total Maximum Daily Load Plan (not mapped)	**Plan Implementation**
Consider development and implementation of total maximum daily load plan for low dissolved oxygen, elevated nutrients, and fecal coliform.	
Swamp Creek P 11 Opportunities for Flood Buyout and Floodplain Restoration (not mapped)	**Flood Buyout/ Restoration**
Implement potential projects identified in the *Swamp Creek Flood Reduction Study* (Kato & Warren, 2001) and by Swamp Creek Technical Committee.	

Table 4-36. Swamp Creek Research

Research No.	Research Description	Factors of Decline Addressed
Swamp Creek R 1	Conduct additional Washington Department of Fish and Wildlife-based Level B analysis on unknown barriers as identified by Level A analysis; develop priority index values for individual passage barriers based on upstream habitat availability and quality.	Fish access and passage barriers
Swamp Creek R 2	Conduct drainage inventory to identify poorly constructed stormwater outfall areas that contribute to drainage problems, streambank erosion, fine sediment accumulation, and water-quality problems. Identify opportunities and needs for regional detention.	Altered hydrology and flow Poor water quality (temperature, other)
Swamp Creek R 3	Investigate observed variability in temperature throughout the Swamp Creek subarea and identify contributing factors (natural or anthropogenic) to higher water temperature. Identify cold-water resources from groundwater.	Poor water quality (temperature)

Map 14. Swamp Creek Subarea

Kelsey Creek

The Kelsey Creek subarea is composed of several streams, all of which drain to the west before entering the east channel of Lake Washington at Interstate 90. (See Map 15, Kelsey Creek Subarea.) The subarea contains more than 19 miles of stream, including Mercer Slough, Sturtevant Creek, Kelsey Creek, Valley Creek, the West Tributary, Goff Creek, Richards Creek, East Creek, and Sunset Creek. The mainstem Kelsey Creek begins in the Phantom Lake and Larsen Lake wetlands, located in the City of Bellevue. The total subarea area encompasses approximately 10,870 acres. Adult chinook salmon have been sighted at the headwaters of the mainstem Kelsey Creek, upstream of Larsen Lake. Chinook salmon are known to occur in portions of Valley Creek, the West Tributary, Goff Creek, and Richards Creek. Kelsey Creek also supports runs of coho and sockeye salmon.

The WRIA 8 Technical Committee identified the following factors of decline for the Kelsey Creek subarea: fish access and passage barriers; increased sedimentation/altered sediment transport processes; poor water quality (increased temperature, other); loss of channel complexity and connectivity ; altered hydrology and flow; and degradation of riparian condition.

The primary goal for the Kelsey Creek subarea is to protect and restore salmon habitat and habitat-forming processes in Kelsey Creek that contribute to the life cycle requirements of adult and juvenile salmon for spawning, rearing, and migration.

The following objectives will help achieve this goal:

- Allow for unimpeded access to all potential natural spawning and rearing habitats for all life stages of chinook salmon in Kelsey Creek and Richards Creek.
- Provide instream conditions that promote stable natural spawning, hydraulic refuge areas, rearing, and unimpeded migration in currently productive salmon distribution areas.
- Restore more natural hydrology, especially peak flows, to protect stream channel complexity, reduce fine sediments, maintain stable spawning beds, and reduce sedimentation.
- Return the erosion and sediment transport processes in the subarea to a more natural equilibrium, which would provide clean spawning gravel, channel stability, and natural phosphorus-loading levels.
- Provide forested buffers that protect ecosystem functions of water temperature regulation, organic inputs, and channel connectivity.
- Identify water-quality parameters affecting salmon survival; reduce pollutant loadings and their impact on salmon.

Tables 4-16 through 4-18 present near-term recommendations for the Kelsey Creek satellite subarea. The tables are organized by action alternatives, potential projects, and research. Action alternatives are general recommendations for actions that should be taken to address an identified factor of decline. Potential projects are more specific on-the-ground opportunities that have been identified for applying an action alternative, such as replanting riparian vegetation at a specific location in a subarea. Research activities are designed to help scientists gain a better understanding of a subarea's factors of decline and to learn what roles the factors play and how to address them.

Table 4-37. Kelsey Creek Action Alternatives

Action Alternative No./Action Alternative	Factors of Decline Addressed	Projects Identified
Kelsey Creek AA 1		
Identify projects that would allow unimpeded access to all potential natural spawning and rearing habitats for all life stages of chinook salmon in Kelsey Creek and Richards Creek.	Fish access and passage barriers	Kelsey Creek P 1
Kelsey Creek AA 2		
Identify opportunities to protect and maintain existing channel complexity and connectivity. Identify opportunities to restore channel complexity and connectivity where necessary.	Lack of channel complexity and connectivity	Kelsey Creek P 2, 3, 4
Kelsey Creek AA 3		
Identify opportunities to protect existing hydrology and to restore more natural hydrology, especially peak flows, in order to protect stream channel complexity, reduce fine sediments, maintain stable spawning beds, and reduce sedimentation. Reduce effective impervious areas by converting grass areas to a forest landscape through incentive programs.	Altered hydrology and flow	Kelsey Creek P 5
Kelsey Creek AA 4		
Identify opportunities to retrofit stormwater retention/detention facilities to better retain, release, treat, and infiltrate stormwater at public and private facilities.	Altered hydrology and flow Poor water quality (other)	No projects identified at this time
Kelsey Creek AA 5		
Identify opportunities to return the erosion and sediment transport processes in the subarea to a more natural equilibrium, which would provide clean spawning gravel, channel stability, and natural phosphorus-loading levels.	Increased sedimentation and altered sediment transport processes	Kelsey Creek P 6
Kelsey Creek AA 6		
Identify opportunities to maintain existing water temperatures and restore cool temperatures where possible.	Poor water quality (temperature)	No projects identified at this time
Kelsey Creek AA 7		
Identify opportunities to protect existing forested riparian buffers and to restore non-forested, degraded riparian areas.	Poor water quality (temperature) Degraded riparian condition Loss of channel complexity and connectivity	Kelsey Creek P 7, 8

Potential projects for the Kelsey Creek subarea are listed in the following table and can be located on Map 15. Each project has been assigned a number (P 1, P 2, etc.), and for projects that include more than one task, a letter has been assigned to each task (a, b, c, etc.). On the map, corresponding numbers and letters indicate the location of the project and task. For example, a map point marked 2a refers to project 2, task a. Not all projects are mapped, because some are not being conducted in a specific location. Projects that are not mapped are noted in the table.

Table 4-38. Kelsey Creek Potential Projects

Project Name	Type of Project
Kelsey Creek P 1 Fish Passage Project Benefiting All Species (Including Chinook)	**Fish Passage**
Replace culverts that are barriers: 1a Obtain permits and rebuild Kelsey Creek Fish Ladder at Mercer Slough. 1b Obtain permits and build new culvert at Bannerwood on Richards Creek. 1c Obtain permits and build new culvert at SE 26th Street on East Creek. 1d Improve fish passage at Washington State Department of Transportation culverts beneath I-405, I-90, and Highway 520 in the Kelsey Creek subarea. 1e Design, obtain permits, and build new culvert at SE 30th Street on Richards Creek. 1f Design, obtain permits, and build new culvert at NE First Street on West Tributary. 1g Determine opportunities for fish passage enhancement and culvert replacement at four partial barriers on private property in the mainstem Kelsey and Richards creek systems. (not mapped) Modify existing culverts that are partial barriers by placing low-flow deflectors on multichannel box culverts to increase depth of low-flow channel: 1h 121st Avenue SE 1i Lake Hills Connector (not mapped) 1j Richards Road. Replace other culverts as identified in culvert assessment report and database.	
Kelsey Creek P 2 Implementation of Greenways Program (not mapped)	**Protection**
Acquire parcels or conservation easements along Kelsey Creek, as identified in the proposed Greenways Program, that are not protected by regulations to preserve remaining wetlands, especially those that would allow enhanced peak flow attenuation and off-channel rearing habitat.	
Kelsey Creek P 3 Installation of Large Woody Debris	**Restoration**
Until peak hydrology can be restored to more natural conditions, design and install large woody debris to provide hydraulic refuge areas during peak flows in the following stream segments: 3a Stream segments 76-03[a] through 76-08 of Kelsey Creek 3b Stream segments 77-02 through 77-03 of Richards Creek 3c Stream segment 79-01 of Sunset Creek 3d Stream segments 80-01 through 80-02 in the West Tributary 3e Stream segments 82-01 through 82-05 of Valley Creek 3f Stream segment 83-01 of Sears Creek.	
Kelsey Creek P 4 Wetland Restoration	**Restoration**
Restore and enhance degraded wetlands to restore off-channel and riparian wetland habitats along stream segment 76-05 of Kelsey Creek, which experienced the impact of a landslide as a result of the Nisqually earthquake.	

Project Name	Type of Project
Kelsey Creek P 5 Protection of Existing Hydrology (not mapped)	**Protection**
Maintain or increase Bellevue's Native Growth Protection Area Program to acquire lands from private property and homeowners' associations and actively manage areas to maintain ecosystem functions.	
Kelsey Creek P 6 Stream Channel Projects	**Restoration**
6a Restore original stream channel of the West Tributary through Kelsey Creek Farm, segment 80-01.	
6b Restore stream channel through Kelsey Creek segments 76-03 through 76-05.	
Kelsey Creek P 7 Protection of Forested Buffers	**Protection**
Purchase riparian forested buffers or conservation easements in the following stream segments:	
7a Stream segments 76-08 and 76-09 of Kelsey Creek	
7b Stream segments 81-01 of Goff Creek	
7c Stream segments 77-01 through 77-03 of Richards Creek.	
Kelsey Creek P 8 Restoration of Riparian Areas	**Restoration**
8a Identify and implement opportunities to plant native coniferous trees in the riparian zones throughout the subarea. First priority should be the mainstem of Kelsey Creek. (not mapped)	
8b Reduce invasive non-native plants in high chinook usage reaches (reed canarygrass and purple loosestrife in segments 76-03 through 76-05 in Kelsey Creek, segments 80-01 through 80-02 in the West Tributary, and segments 77-01 through 77-02 in Richards Creek).	

[a] City of Bellevue stream segment numbering system, based on state protocols defined by Washington Department of Natural Resources (Pleus and Schuett-Hames 1998) and adopted by the Salmon and Steelhead Habitat Inventory Assessment Program

Table 4-39. Kelsey Creek Research

Research No.	Research Description	Factors of Decline Addressed
Kelsey Creek R 1	Evaluate the requirements for stream channels in equilibrium (stable) based on existing peak and base flows in Kelsey Creek.	Loss of channel complexity and connectivity
Kelsey Creek R 2	Evaluate existing stream hydraulic conditions in relation to stream channel configuration, flow gauging information, and stormwater facility operations.	Altered hydrology and flow
Kelsey Creek R 3	Evaluate capacity for reducing peak flows to mid-1970 levels through modifications of existing stormwater drainage facilities.	Altered hydrology and flow
Kelsey Creek R 4	Install monitoring equipment for the proposed green roof at Mercer Slough Environmental Education Center as a combined educational and technical research study to determine the value of green roofs for stormwater retention and water-quality mitigation.	Altered hydrology and flow
Kelsey Creek R 5	Investigate use of cisterns, permeable pavements, rainwater harvesting, downspout disconnection programs, detention tanks under parking lots, and other on-site and off-site best management practices for reducing peak flows.	Altered hydrology and flow
Kelsey Creek R 6	Evaluate existing flow information and install additional flow gauging stations as needed to analyze stream flows and impacts on stream stability.	Altered hydrology and flow

Research No.	Research Description	Factors of Decline Addressed
Kelsey Creek R 7	Investigate water temperature conditions during summer low flow conditions and during salmon migration and spawning; in particular, note the size of buffer widths necessary to affect a change in temperature.	Poor water quality (temperature)
Kelsey Creek R 8	Work with Washington Department of Ecology to investigate 303(d) pesticide listing for headwaters of Kelsey Creek near Larsen Lake.	Poor water quality (other)
Kelsey Creek R 9	Analyze pollutant spill response records to identify areas of highest incidence or common pollution issues to develop focused education, inspection, and enforcement programs.	Poor water quality (other)
Kelsey Creek R 10	Develop and implement a monitoring program for Mercer Slough to determine baseline conditions for sedimentation, water temperature, pesticides, and other water-quality parameters. These baselines will be used in an adaptive management program to maintain ecosystem functions.	Poor water quality (other)
Kelsey Creek R 11	Analyze historical private retention/detention facility inspection data to determine effectiveness of existing inspection schedule and make recommendations for source control, facility maintenance frequency, and code revisions.	Altered hydrology and flow Poor water quality (other)

Map 15. Kelsey Creek Subarea